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YUKON RIVER ANADROMOUS FISH INVESTIGATIONS
TECHNICAL REPORT FOR PERIOD
JULY 1, 1977 to JUNE 30, 1978

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Yukon River Salmon Studies

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ABSTRACT

The 1977 commercial catch of 96,400 king salmon was the largest since 1974. The subsistence catch for this species was 17,581 fish. Summer chum salmon commercial catches in 1977 totaled 549 thousand. The total commercial harvest of fall chums in 1977 was 248 thousand and the subsistence catch equaled 258,600. Escapements in 1977 were generally good to excellent for both king and chum salmon.

The expanded Anvik tower count of 163 thousand summer chum salmon in 1977 ranks fourth since the project was initiated in 1972. The 1977 Anvik tower count of 1,261 king salmon was the highest since the project was initiated.

During 1976 and 1977, 6,575 fall chum salmon were tagged in the area of the mid-Yukon villages of Galena and Ruby. To date 2,518 or 38% of the chums tagged have been recovered. Two hundred and forty-two coho were tagged during these operations. The current tag recovery for coho stands at 24%.

Eighty-six percent of the recoveries for south bank tagged chums have been made in Tanana drainage while 94% of chums tagged along the north bank have been recovered in the upper Yukon drainage.

Simple Petersen population estimates of the Yukon fall chum run are: 1977, 520 thousand and 1976, 149 thousand. An exploitation rate of 0.644 was calculated for 1977 and 0.756 for 1976.

INTRODUCTION

The objectives of ongoing Yukon research have been to: (1) determine the magnitude and effect of commercial and subsistence harvests on the various stocks of king and chum salmon, (2) develop estimates or indices of the magnitudes and quality of king and chum salmon runs and escapements, (3) relate collected data to long-term trends in the salmon stocks, and (4) evaluate management procedures needed to maintain salmon at the level of optimum sustained yield.

This report has been prepared primarily as a review of data collected in the course of field work during the 1977 summer-fall season. The major projects discussed are: (1) Anvik River counting tower and sonar, and (2) Yukon River fall chum and coho stock separation. Supportive studies which contribute to the overall objectives of Yukon fisheries investigations were discussed at length in the 1976 annual Technical Report (Mauney 1977). These studies have been summarized in the Annual Yukon Area Management Report and include: (1) commercial catch data analysis, (2) subsistence fishery survey, (3) Flat Island test fishing studies, (4) Yukon Territory salmon escapement studies, (5) aerial surveys, and (6) Salcha and Delta River studies (Geiger and Andersen 1978). The results of these studies for the 1977 field season will be summarized in this report. Figures 1 through 4 show the Yukon River and its major tributaries.

SUPPORTIVE STUDIES

Commercial Catch Data Analysis

Yukon River commercial fishery catch statistics (including date, location, and numbers of fish) are recorded on fish tickets when the fish are purchased from the fishermen. The tickets are collected from the processors by Department personnel after the end of each fishing period. From these tickets total catch, catch per unit effort, and numbers of fishermen are compiled and recorded on a master sheet.

The 1977 Yukon commercial fish harvest, including subsistence roe sold, yielded $4,015,000 for its fishermen.

The 1977 commercial catch of 96,400 king salmon was the largest since 1974. The subsistence catch for this species was 17,581 fish. Summer chum salmon commercial catches in 1977 totaled 549 thousand. The total commercial harvest of fall chums in 1977 was 248 thousand and

Figure 1. Yukon River Map

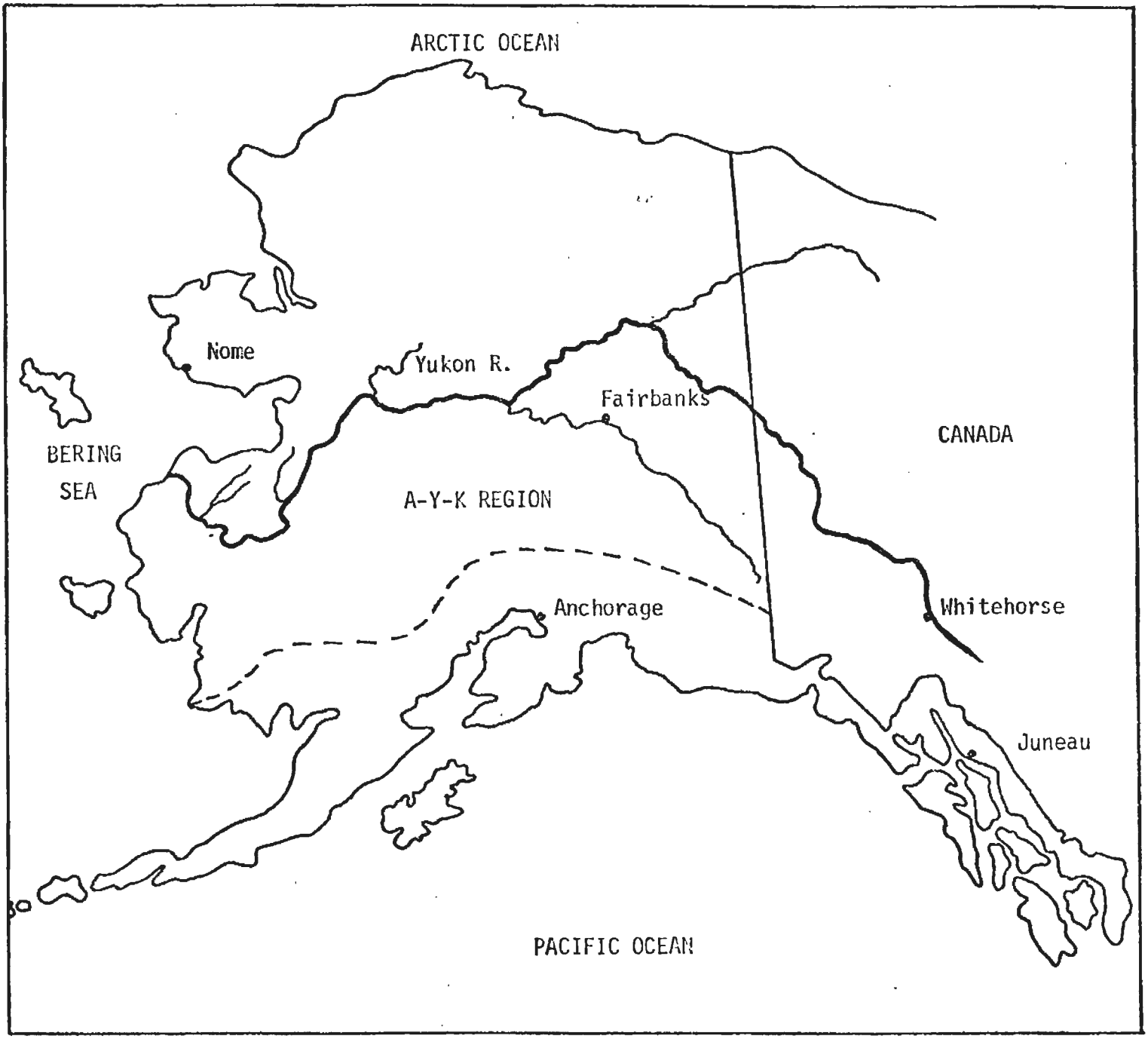


FIGURE 2. Lower Yukon River map.

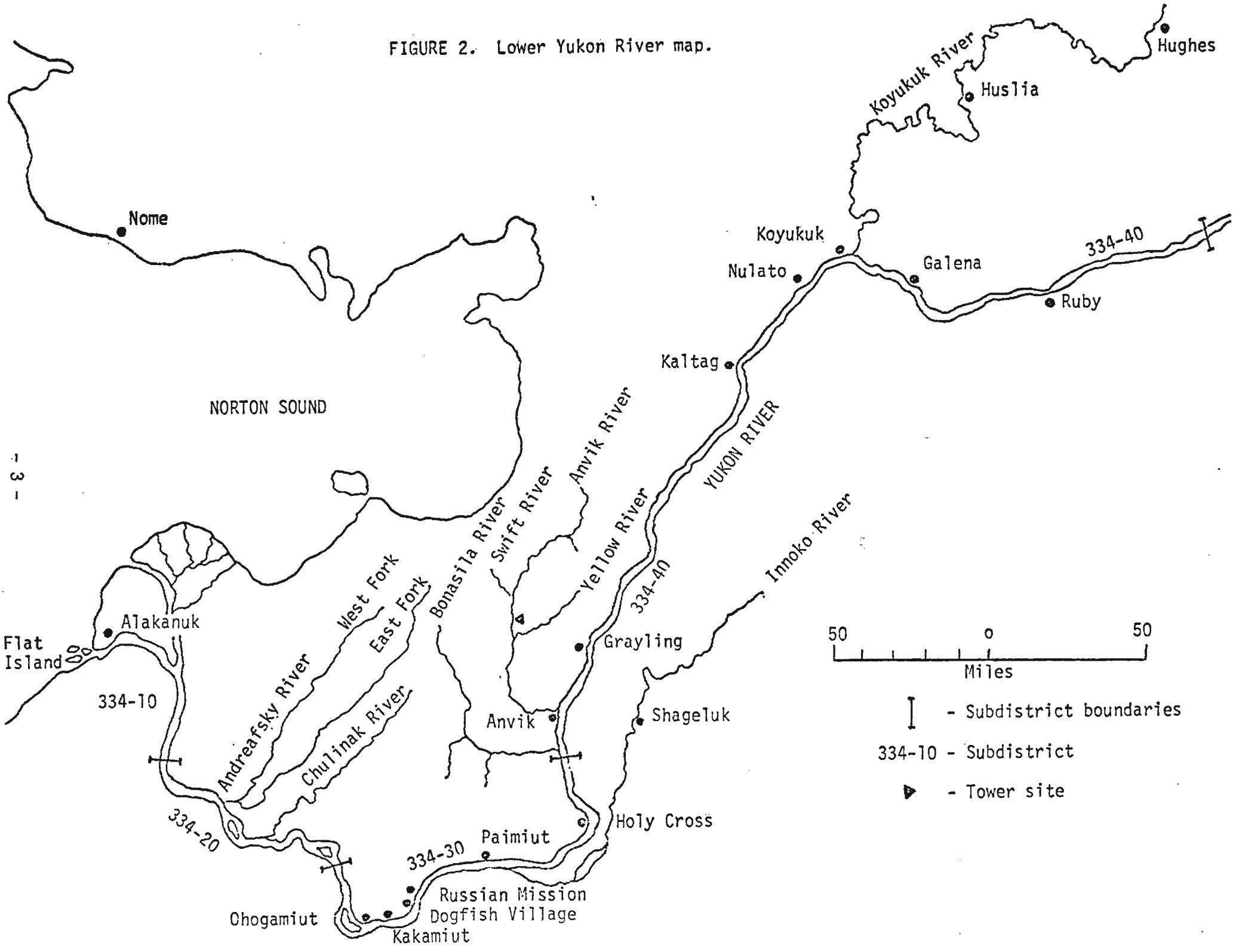


FIGURE 3. Mid-Yukon River map

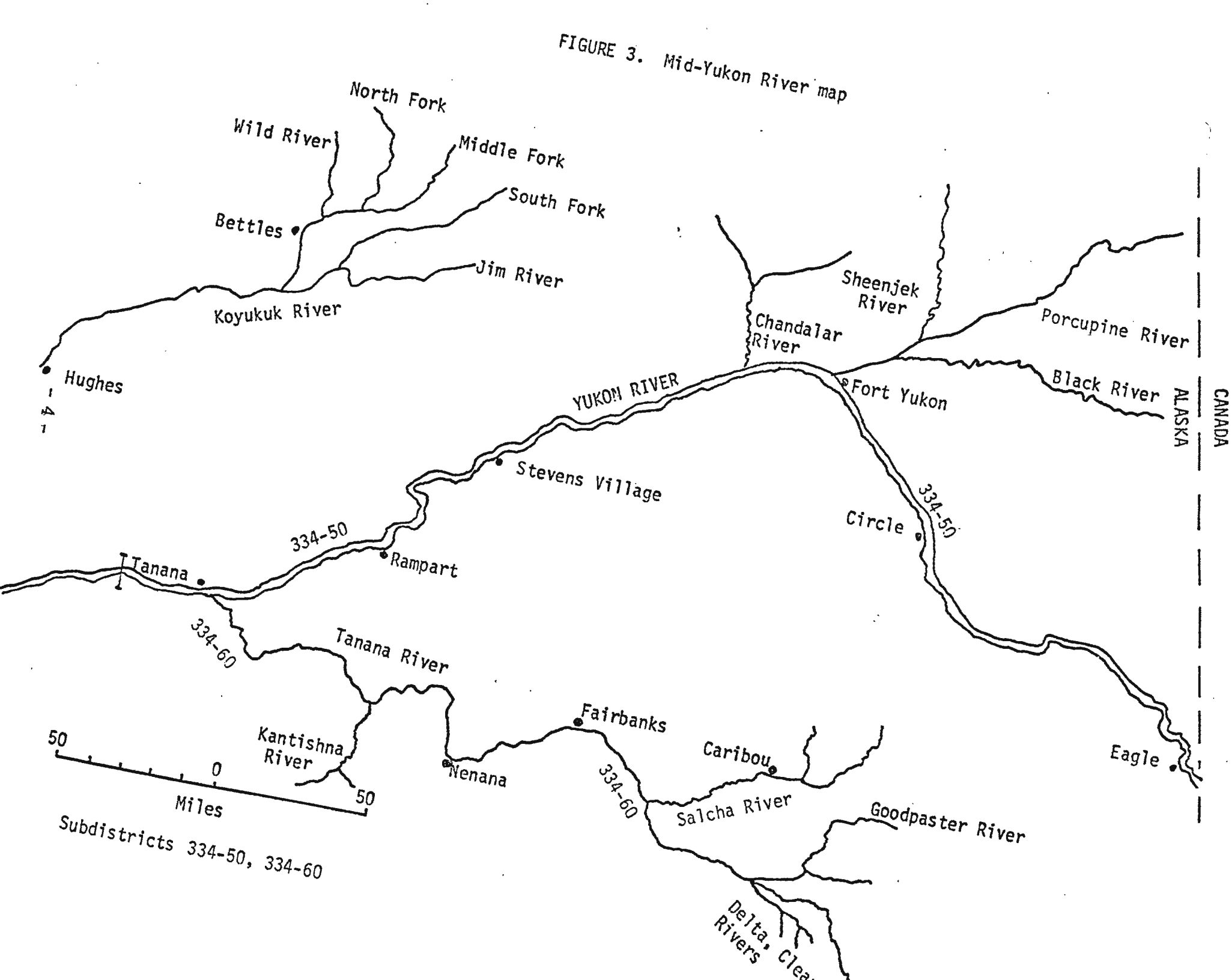
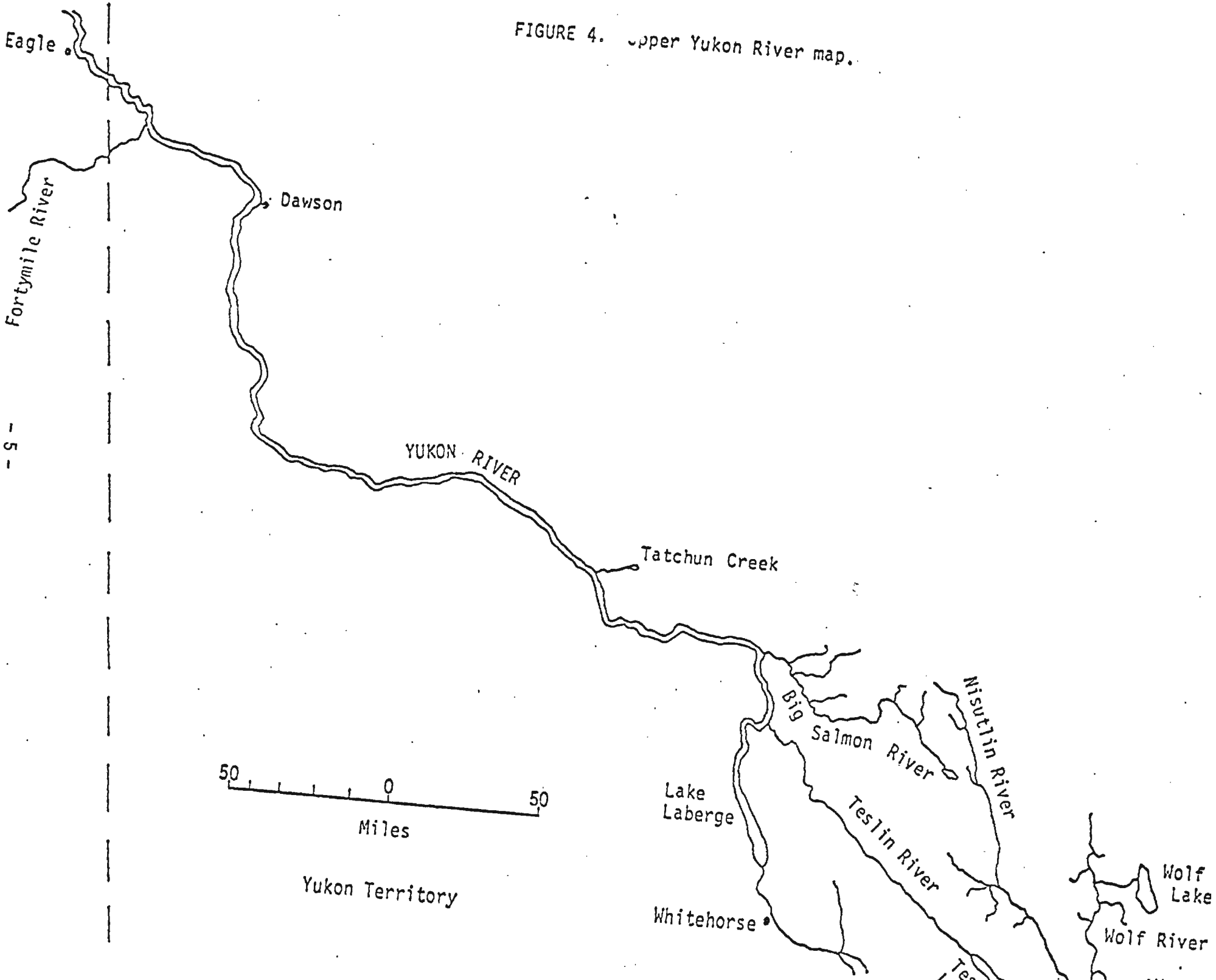


FIGURE 4. Upper Yukon River map.



subsistence catch was 258,600. Escapements in 1977 were generally good to excellent for all three of these salmon species in the Yukon system.

Subsistence Fishery Survey

Each year at the summer's end, Department personnel conduct a subsistence fishery survey of the entire river by boat and aircraft stopping at each village and interviewing fishermen to obtain an estimate of the total number of each species of salmon taken and related effort data. Special catch calendars are mailed to most fishing families prior to the season and facilitate catch reporting. The few fishermen not interviewed are sent catch questionnaires after the fishing season ends. In 1977, 17,581 kings and 258,600 chums (includes coho) were taken for subsistence from the Yukon River drainage (Geiger and Andersen 1977).

Flat Island Test Fishing

A test fishing site has been maintained at Flat Island in the south mouth of the Yukon River since 1963 (Figure 5). The Flat Island site is located downstream from most of the commercial fishing effort permitting the salmon run to be assessed before it reaches the commercial fishery. The data obtained from this site has been important for in-season management and in assessing the long-term effects of the commercial fishery on the king and summer chum salmon runs.

Sampling gear consists of set gillnets of 8-1/2" (king salmon gear) and 5-1/2" (chum salmon gear) stretched mesh. Each net is 25 fathoms long and the depths of the nets are 28' (8-1/2") and 45' (5-1/2") meshes. The nets are fished 24 hours a day at index locations during June to mid-July and checked three times daily.

Test fishing catches in gill net hours are presented in Table 1 for the past 10 years and indicate rough trends in fish abundance. The catch success in 1975 was high with a value of 4.21 for chums while in 1977 the value was relatively lower (1.41).

Salcha River Studies

The Salcha River is the most important king and summer chum salmon producer of the Tanana River drainage and is the only major Yukon River system where comprehensive king salmon escapement information has been

Figure 5. Flat Island test fishing sites, Yukon River, 1976

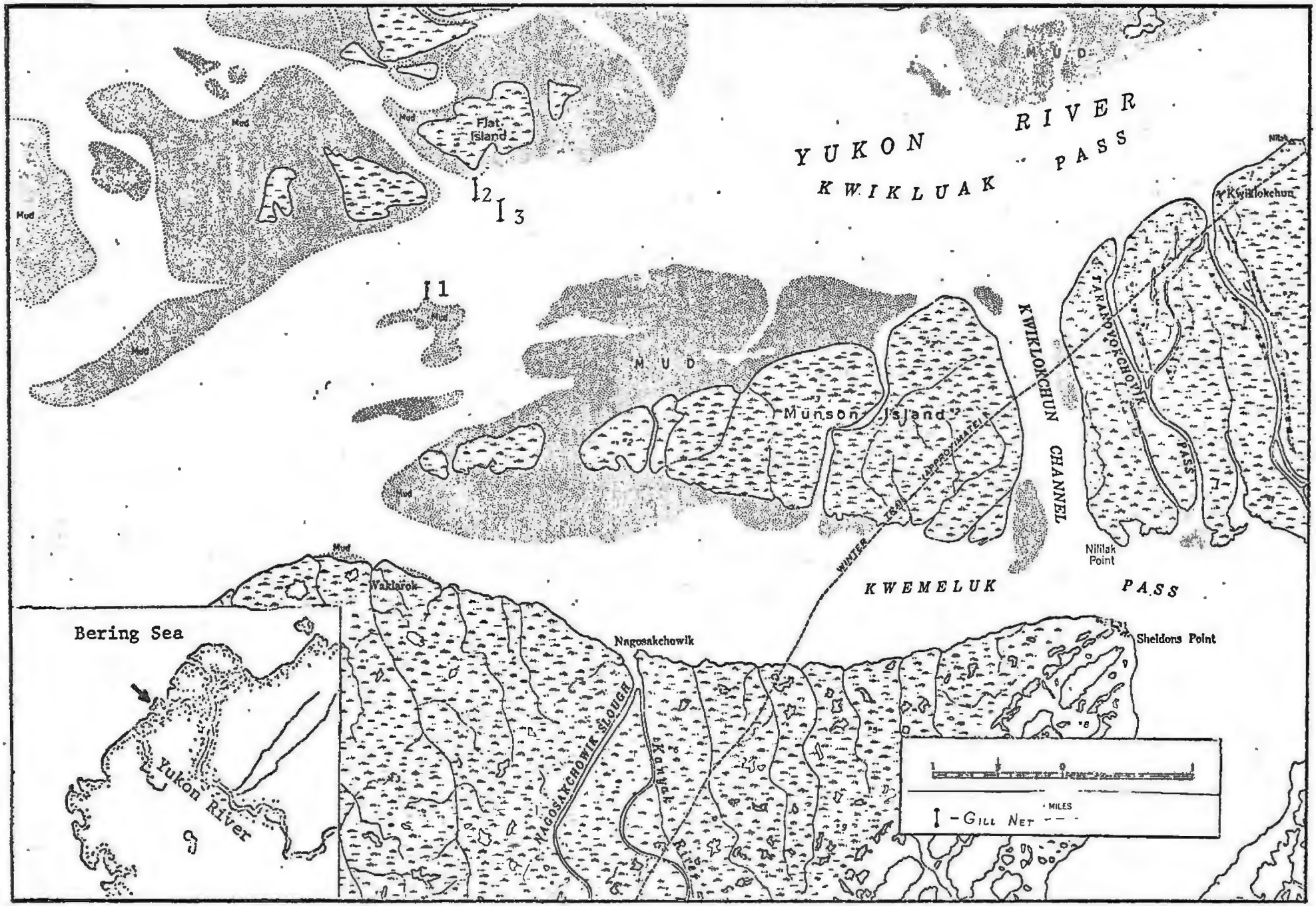


Table 1. Relative efficiency for various types of fishing gear operated at Flat Island, Yukon River, 1965-1977.

Year	Types of gear	Gill net hours	Catch per gill net hour	
			King salmon	Chum salmon 1/
1965	10" mesh gill net	376	0.22	
	8½" mesh gill net	456	1.44	
	7" mesh gill net	128	0.91	
	8½" mesh gill net	216	1.58	
1966	7" mesh gill net	117	0.26	
	8½" mesh gill net	198	0.76	
1967	5½" mesh gill net	196	0.28	1.30
	8½" mesh gill net	431	0.41	0.42
1968	5½" mesh gill net	628	0.26	0.30
	8½" mesh gill net	616	0.72	0.43
1969	5½" mesh gill net	368	0.33	4.18
	8½" mesh gill net	792	0.72	0.93
1970	5½" mesh gill net	601	0.20	2.92
	8½" mesh gill net	1,275	0.74	0.78
1971	5½" mesh gill net	422	0.15	1.85
	8½" mesh gill net	899	0.89	0.78
1972	5½" mesh gill net	721	0.03	0.83
	8½" mesh gill net	1,453	0.42	0.43
1973	5½" mesh gill net	846	0.15	2.82
	8½" mesh gill net	1,530	0.50	0.69
1974	5½" mesh gill net	1,014	0.11	4.14
	8½" mesh gill net	1,813	0.26	0.95
1975	5½" mesh gill net	671	0.14	4.21
	8½"mesh gill net	1,519	0.21	0.29
1976	5½" mesh gill net	771	0.12	3.02
	8½" mesh gill net	1,535	0.35	0.64
1977	5½" mesh gill net	864	0.05	1.41
	8½" mesh gill net	1,632	0.37	0.37

1/ Chum salmon catch data was not recorded for 1966.

collected. Results of the Salcha River studies are detailed in the commercial fish-technical evaluation study of the Trans-Alaskan Pipeline (Francisco and Dinneford 1978).

The summer chum salmon escapement as estimated by surveys in the Salcha River during 1977 totaled 677 fish. The annual escapements for this system have ranged from 290 to 8,040 chums (excluding poor or incomplete surveys).

In 1977 the estimated king salmon escapement for the Salcha River was 1,200. The annual escapement in this system has ranged from 249 to 2,878 kings (excluding poor or incomplete surveys).

Delta River Studies

Delta River studies were continued in 1977 with Alyeska funding. The objectives of the 1977 studies were:

1. Determine the distribution, abundance, and timing of fall chum salmon populations in the Delta River spawning areas.

2. Sample chum and coho salmon escapement for age, sex, and size information.

3. Determine percentage of population that could be effected by an oil spill through life histories and run timing studies.

The fall chum salmon escapement for the Delta River was estimated to be 18 thousand in 1977. This was a record high escapement since documentation began in 1972. Results of the Delta River studies for 1977 are presented in a special report (Francisco and Dinneford 1978).

Yukon Territory Salmon Escapement Studies

Environment Canada-Fisheries Service personnel enumerated and sampled king salmon migrating through the Whitehorse fishway in 1977. The fishway is located at the Whitehorse Dam upstream of the city of Whitehorse and is one of the farthest upstream king salmon escapement monitoring points on the Yukon River. Since 1969 the annual fishway counts and the age and sex composition of the run have been used as a possible indicator of the effects of the downriver fishery on king salmon escapement in the Canadian portion of the Yukon drainage. The objectives of the study over the years have been to: (1) obtain a daily and seasonal count of king

salmon escapement through the fishway, and (2) determine the age, sex, and size composition of the Whitehorse escapement.

Two hundred and seventy-seven king salmon were enumerated at the Whitehorse fishway in 1977. An examination of the annual escapement counts since 1959 indicates that the Whitehorse run has experienced a serious decline. Possible reasons for the decline are discussed in detail in the 1973 Yukon River Anadromous Fish Investigations Report (Trasky 1974).

During 1977, aerial and foot surveys were conducted in Canada of major spawning streams with Alaska Department of Fish and Game personnel participating in some surveys.

Fall chum salmon escapements of the Fishing Branch River in northern Yukon Territory were monitored by Alaskan personnel in 1977. A 10-mile spring-fed section of the south fork of this river remains ice-free over winter and is heavily used by fall chums (Elson 1976). A total of 33 thousand chums were estimated by aerial survey in 1977. During the years 1973-75, a weir was used to obtain total escapement counts. Numbers of chum salmon enumerated past the Fishing Branch weir in 1975 was an all-time recorded high of 353 thousand fish.

A total of 6,918 chum salmon were harvested by commercial and subsistence fishermen in the Yukon Territory during 1977 (Ottmann 1978). These chums were largely fall fish. A total of 5 thousand king salmon was harvested in the Yukon Territories commercial and subsistence fisheries combined during 1977.

Aerial Surveys

Because of the vast distances between salmon spawning streams in the Yukon River drainage, salmon escapements are primarily assessed by aerial survey methods. Index streams have been chosen which were felt to be indicative of overall Yukon River basin escapements. During the peak of spawning, and when water and light conditions are optimum for viewing, these streams are surveyed by Department biologists in single engine aircraft. While not precise, aerial surveys are an important management tool when no other means of assessing escapements are available. Escapement indices obtained from tower counts and aerial surveys give a post-season check of in-season management strategy in obtaining desired escapement levels.

In 1977, king salmon escapements into the major spawning areas ranged from above average to average. Escapements in the lower portion

of the drainage were judged excellent. However, escapements in the Yukon Territory were judged fair at best.

Summer chum escapements in 1977 were judged good downstream of the Koyukuk River based on selected surveys. Both the Anvik and Andreafsky River systems, for which fair historical records exist had large runs in 1977. In Table 2 the top 10 summer chum salmon streams in the Yukon River system are ranked based on numbers of spawners. The Anvik River system accounted for 53% and the Andreafsky system 28% of the combined Yukon River summer chum observed escapement for the top 10 producing streams in 1974 through 1977.

Aerial surveys continued as the only method currently available to assess fall chum escapement in most Alaskan waters (see Figure 11 for major Yukon fall spawning areas). Environmental and light conditions during peak fall chum spawning, late September through mid-November, are generally less conducive to reliable surveys than during the summer. Short periods of daylight, shadows, streams running ice, and snow squalls are limiting factors encountered during fall surveys.

Fall chum escapements were considered fair in the Toklat, Sheenjek, and Fishing Branch Rivers during 1977. These streams accounted for 86% of total documented fall chum escapements for the years 1974 through 1977 combined (Table 3). In Table 3 the top 10 fall chum salmon streams for 1974 through 1977 are ranked based on numbers of spawners.

ANVIK RIVER SALMON ESCAPEMENT STUDIES

Introduction

Salmon were enumerated for the sixth consecutive year to obtain indices to the magnitude of king and summer chum salmon escapements in the Anvik River system. The objectives of this project were to: (1) determine the daily and seasonal timing and magnitude of the salmon escapements; (2) evaluate various enumeration methods by comparing aerial survey, boat survey, and tower counts; (3) determine age, sex, and size components of the king and chum salmon escapements; (4) evaluate different counting tower schedules; (5) measure climatological and hydrological conditions; and (6) undertake preliminary on-site evaluation of a Bendix Corporation acoustic side scan salmon counter.

The Anvik River is the single most important chum salmon producer in the Yukon drainage. A record level 1 million chum is believed to have returned to the Anvik in 1975.

Table 2. Top 10 Yukon River system summer chum salmon streams ranked by observed escapement 1974 through 1977[1/].

Ranking	1977 Stream	1977 Escapement	1976 Stream	1976 Escapement	1975 Stream	1975 Escapement	1974 Stream	1974 Escapement
1	Anvik	269[3/5/]	Anvik[3/5/]	406	Anvik[3/]	813	Anvik[4/]	201
2	Andreafsky East	113	Andreafsky West	118	Andreafsky West	236	Andreafsky West	33
3	Andreafsky West	63	Andreafsky East	105	Andreafsky East	223	Nulato South	28
4	Nulato North	58	Rodo	38	Nulato North	87	Nulato North	22
5	Rodo	16	Chulinak	34	Gisasa	57	Gisasa	22
6	Thompson	15	Nulato North	27	Nulato South	51	Rodo	16
7	Nulato South	11	Gisasa	21	Rodo	25	Salcha	8
8	Gisasa	2	Thompson Creek	17	Caribou Creek	15	Chena	4
9	Clear	2	Nulato South	12	South Fork Koyukuk	15	Andreafsky East[2/]	3
10	Mt. Village	2	Caribou Creek	11	Melozitna	9	Dishna[2/]	3
Total		551		789		1,531		340

1/ Escapement in thousands of salmon.
2/ Streams surveyed under poor survey conditions.
3/ Includes sum of tower and aerial counts.
4/ Tower count only.
5/ Includes Yellow River.

Table 3. Top 10 Yukon system fall chum salmon streams ranked by observed escapement, 1974 through 1977[1/].

Ranking	1977 Stream	1977 Escapement	1976 Stream	1976 Escapement	1975 Stream	1975 Escapement	1974 Stream	1974 Escapement
1	Fishing Branch	33	Toklat	37	Fishing Branch	353	Sheenjek	41
2	Toklat	25[2/]	Fishing Branch	13	Toklat[2/]	78	Toklat	34
3	Sheenjek	21	Sheenjek	12	Sheenjek	78	Fishing Branch	33
4	Delta	18	Delta	6	Yukon River (Mainstem, Canada)	7	Chandalar	17
5	Bluff Cabin Slough	6	Tanana	5	Chandalar	6	Bluff Cabin Slough	5
6	Chandalar	4[2/]	Bluff Cabin	3	Bluff Cabin Slough[2/]	6	Tanana	5
7	Upper Tanana	4	Delta Clwtr. Slough	2	Delta	4	Delta	4
8	Delta Clearwater	2	Benchmark 737 Sl.	3/	Bear Paw	2	Bear Paw	3
9	Benchmark 735	1	Richardson Clwtr.[2/]	3/	Black[2/]	2	Black	2
10	Kluane	1	Chandalar[2/]	3/	Delta Clwtr. Slough[2/]	1	Seventeen Mile Sl.	2
Total		115		78		536		146

1/ Escapement in thousands of salmon.
2/ Poor survey conditions.
3/ Less than 500 fish.

The Anvik is also a major contributor to Yukon king salmon production. It is one of the four Alaskan tributaries regularly documented to have escapements in excess of 1 thousand kings.

A physical description of the Anvik system as well as an abridged listing of its flora and fish species was included in the 1976 Job Completion Report (Mauney 1977). Water temperature data for the years 1973-1977 is presented in Appendix Table 1.

Materials and Methods

Materials and methods used in the counting tower operation were similar to those used by Trasky in 1974 (Trasky 1974) and by Mauney in 1975 and 1976 (Mauney 1978).

The Robinhood Creek tower site is located some 70 miles upstream from Anvik Village (the Anvik enters the Yukon at Yukon River mile 317) (Figure 6). Materials for weir construction were transported to the Robinhood Creek site from Anvik Village by riverboat and from Bethel by aircraft following ice-out in early June. Tents for living, mess quarters, and for equipment storage were erected on the west bank of the river immediately downstream from the planned weir site.

By June 26 of 1977 the water level at the Robinhood Creek location had dropped sufficiently for weir construction to begin. The weir was essentially completed on June 29 following 3 days of installation. The entire width of the river was weired with the exception of a 40-foot center section (Plate 1) where maximum flow rate and water depth were reached. Boats could pass up and downstream through the weir opening. The counting tower was erected on a log raft anchored just upstream of the weir opening.

Daily counts were begun on June 26, 1977. Counting shifts were normally a maximum of 2 hours duration. Char and grayling were enumerated to gain information concerning the numbers of non-salmon fish species passing the weir site. Salmon migrating at the rate of 20 miles per day would require some 18-20 days to reach the Robinhood Creek tower site from the Yukon mouth.

Char and grayling enumeration was continued through July 3. After this date, counts were essentially limited to salmon. Weir counts terminated on July 26 when net upstream chum and king salmon migration had fallen to very low levels.

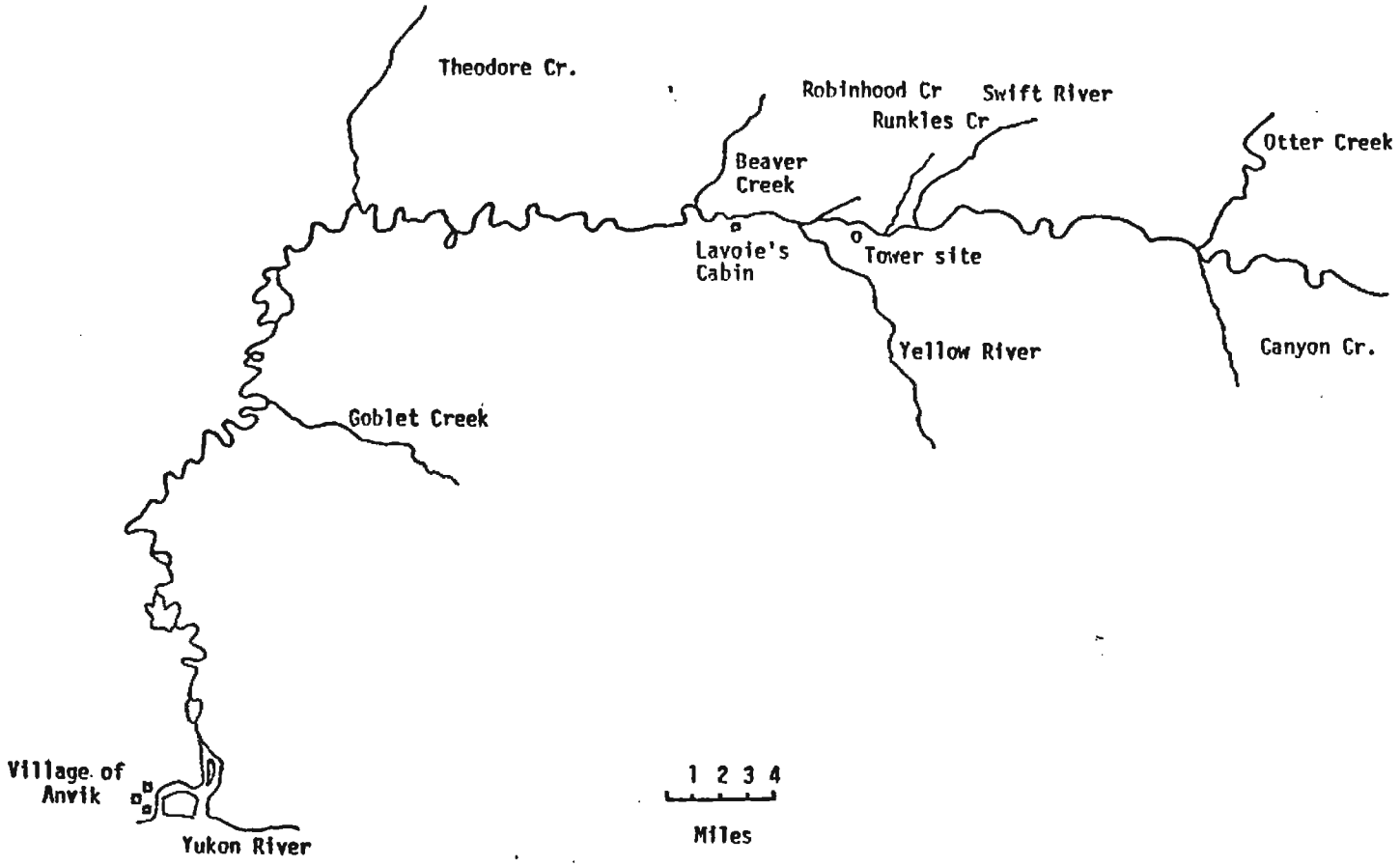


Figure 6. Anvik River map.

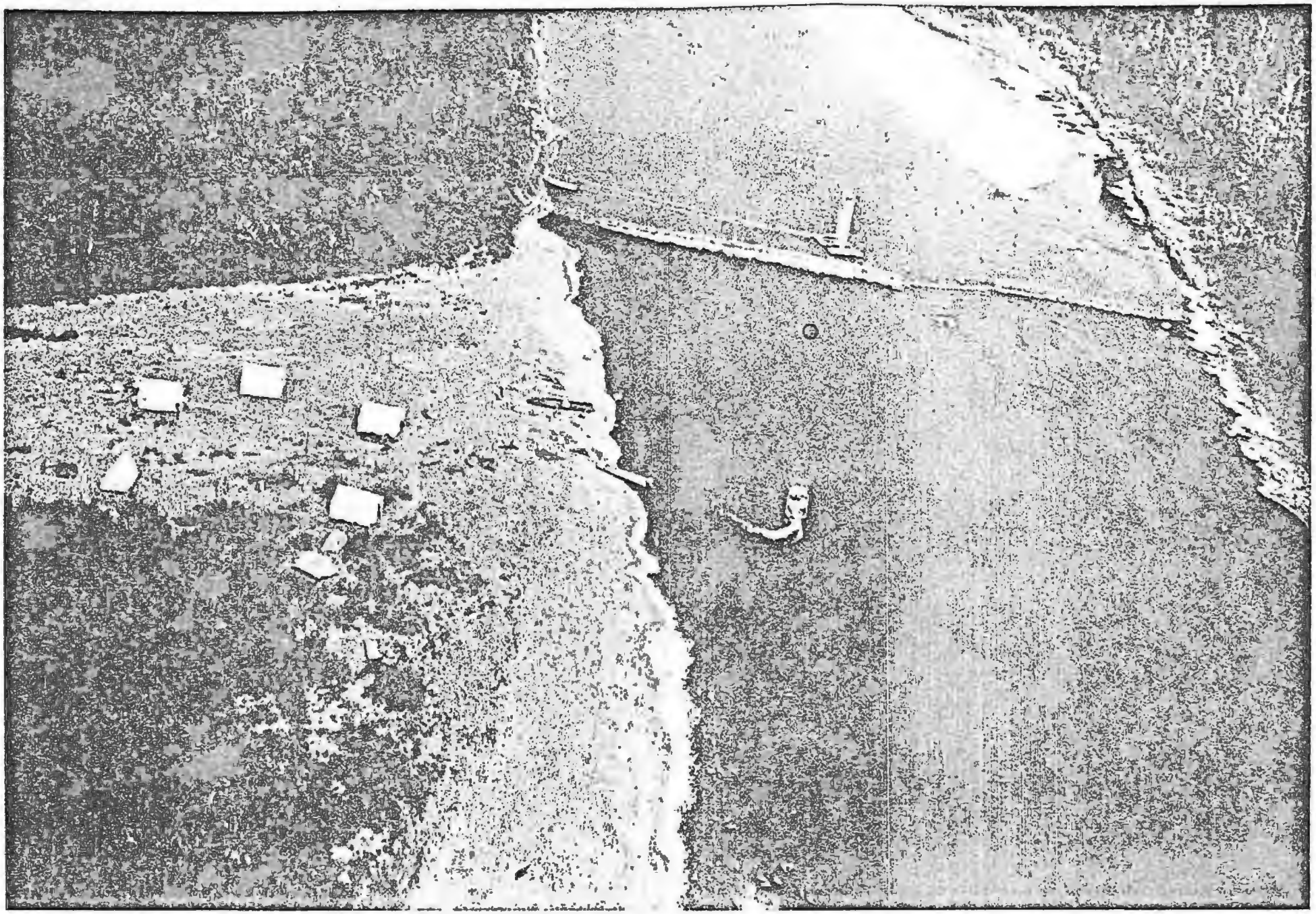


Plate 1. Anvik River counting tower, Robinhood Creek site.

Chum salmon carcass sampling and enumeration surveys were conducted from boats upstream and downstream of the tower site from July 23 to July 30. A scale smear was taken from each fish examined, length (mideye to fork of tail) measured, and sex of each carcass recorded. King salmon carcass surveys were made of the main Anvik River above Lavoie's cabin from August 1 through 12. Data collected was the same as for chum salmon.

Aerial surveys on July 16 enumerated king and chum spawners and carcasses and determined distributions within the river system below the counting tower. These surveys included Beaver Creek and Yellow River tributaries. Survey reliability for the lower Anvik and Yellow River was judged 50% or less due to turbid water conditions. Spawning king salmon were counted between the 1975 tower site and Beaver Creek on July 29 (a distance of some 8 miles) by drifting in a boat.

A beach seine was used during July to locate and capture juvenile salmon for age/growth data. This was the third season of juvenile salmon collections in the Anvik River. Seining for juveniles was conducted in the areas of the Old and Robinhood Creek tower sites by the project leader and a technician as other activities permitted.

Five personnel operated both the tower and sonar installation in 1976 and 1977. Three persons were used in 1974 and 1975 when only the counting tower was in operation.

Twenty-four hour tower counts were made for most of the 1977 season. Counts during the 1974 and 1975 seasons were confined to the hours in which the greatest percentage of the chum migration had been documented in 1973, i.e., 2400 to 0700 and 1300 to 2400 hours.

Results and Discussion

Arctic char and Arctic grayling

An expanded combined total of 1,691 char and grayling was counted past the Robinhood Creek tower site from June 27 through July 3, 1977 (Table 4). Char and grayling could not be reliably distinguished between from the counting tower height under varying light conditions. The actual count for these species was 1,499 over 48 hours for 1976. In 1977 the actual count was 1,031 over 96 hours.

Table 4. Char and grayling counts past the Anvik tower June 27-July 3, 1977 1/.

Date	Net upstream	No. hours counted	Expanded daily total
6-27	16	12	32
28	18	12	36
29	44	12	88
30	497	18	663
7-1	281	12	562
2	85	12	190
3	90	18	120
Total	1,031	96	1,691

1/ After July 5 only salmon were counted; char and grayling could not be reliably distinguished from the counting tower height of 25 feet.

Summer chum salmon

Timing. The first chum in 1977 was observed at the new tower site on June 29, in 1976 on July 1, and in 1975 on July 5. Chum migration past the tower showed a normal pattern in 1977 (Figure 7). Upstream movement picked up very rapidly starting July 4; on July 11 the peak daily count for the season of 21,019 fish was recorded. Only 1976 has shown an earlier peak count for chum. The 98% level of the run was reached on July 21, 1977 (Appendix Table 1). Chum were still moving upstream in substantial numbers on this date in 1975 and in 1976.

Hourly migration patterns for the same 18 hour period during 1974-1977 are shown for chum salmon in Figure 8. Migration patterns in 1977, as in earlier years, indicated generally reduced movement between 0700 and 1300 hours. Least movement for chum salmon during 1974, 1976, and 1977 occurred between 0600 AM and 1200 PM (8%) movement. The best "compromise" time period to omit counts when king enumeration is considered along with chum was from 0300 to 0900 (21% chum movement).

Cunningham (1976) found that over the 4 days on which 24-hour counts were conducted from the Chirosky River counting tower in Norton Sound, low chum, king, and pink salmon movement was between the hours of 0700-1300. Kuhlmann (1976) stated that based on data from 1965 and 1969, when 24-hour counts were made, the average percent of daily chums and pink salmon escapement past the Kwiniuk River tower during the hours of 0600 through 1200 was 2.1 and 3.66 respectively. Data presented by Baxter (1976) for

Figure 7. Comparison of daily migration patterns for chum salmon, Anvik River, 1974-1977.

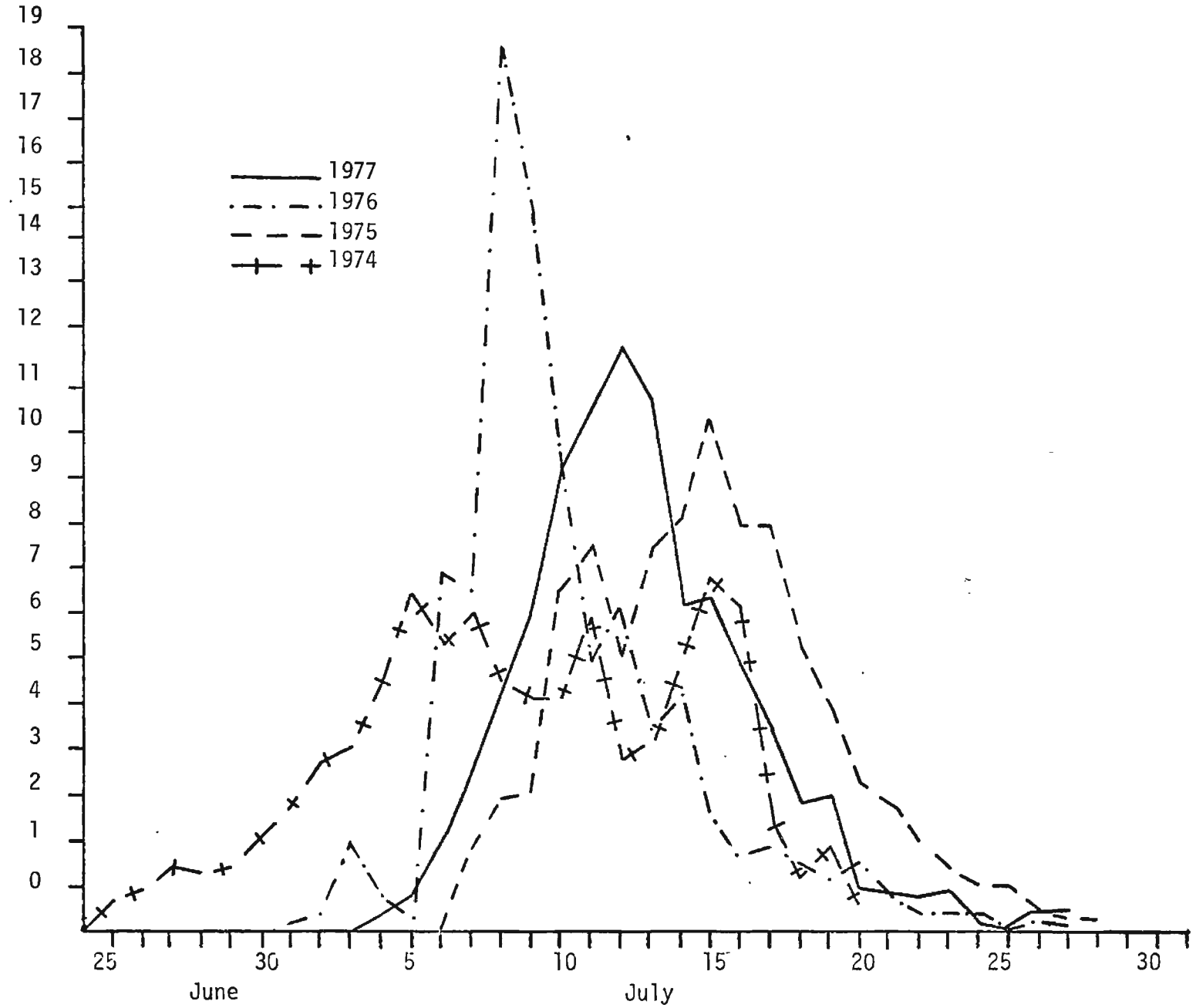
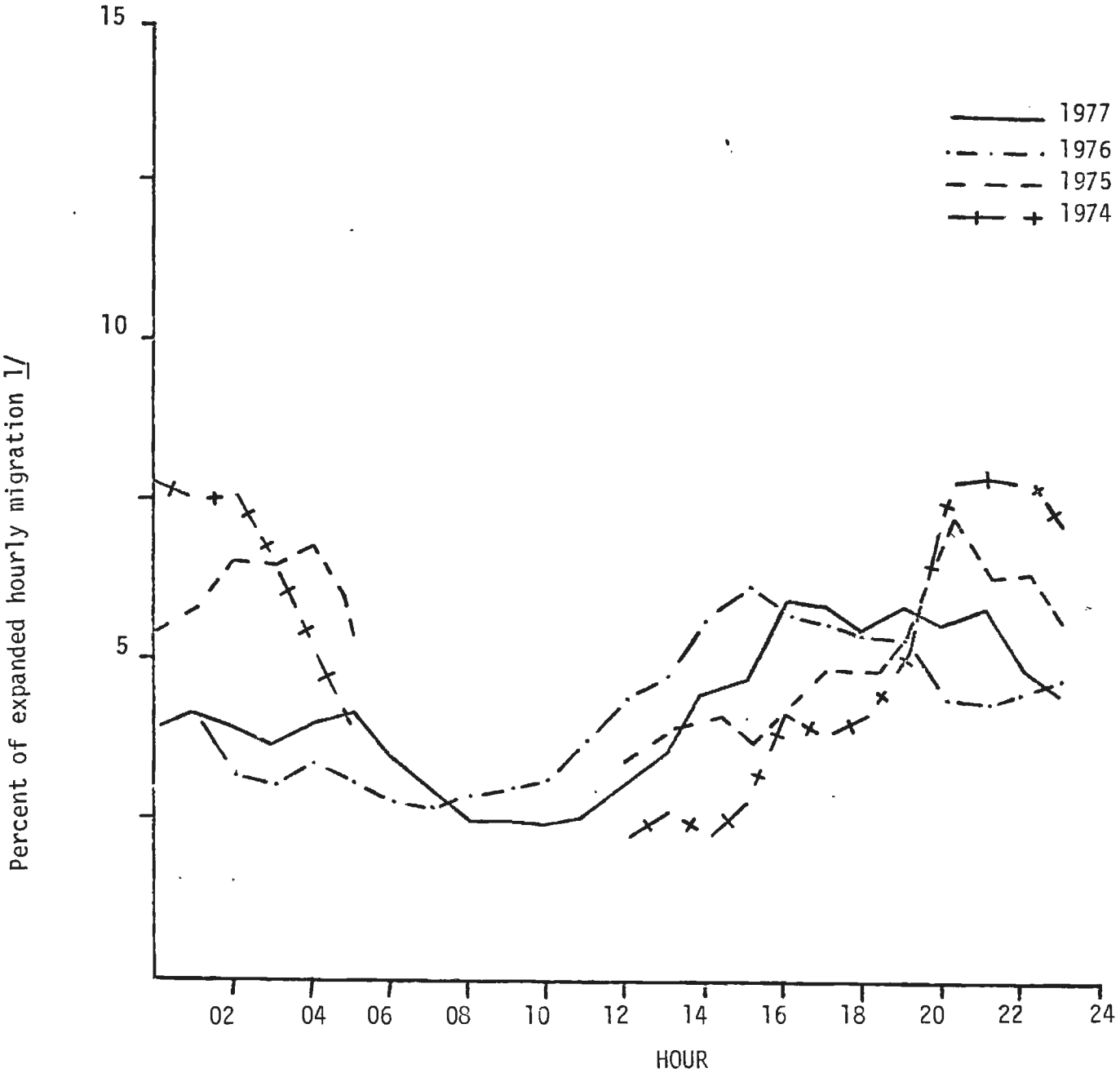


Figure 8. Comparison of hourly migration patterns for chum salmon, Anvik River, 1974-1977.



1/ Based on expanded 18 hour percent.

the Holitna River weir and tower showed the low 6-hour period of chum migration to be from 0100 through 0700.

Downstream movement of chums as a percentage of upstream movement for 1972 through 1977 is given in Table 5. The percentage has fluctuated from a low of approximately 3% in 1972 to a high of 20% in 1976 for a yearly average of 10%.

Table 5. Anvik River chum and king salmon movement upstream versus downstream compared for years 1973-1977 1/.

Year	Number upstream	Number downstream	Net upstream	Downstream movement expressed as % of upstream
		Chum Salmon		
1972	65,202	2,239	62,963	3.4
1973	76,904	6,483	70,421	8.4
1974	149,753	14,629	135,124	9.8
1975 1/	284,830	24,511	260,319	8.6
1976	229,077	43,866	185,211	19.5
1977	159,595	5,523	154,372	3.5
Total	965,361	97,251	868,110	10.1
		King Salmon		
1973	539	112	427	20.8
1974	338	30	308	8.9
1975 2/	-	-	-	-
1976	908	208	700	22.9
1977	1,204	78	1,128	6.5
Total	2,989	428	2,561	14.3

1/ Movement data available through 7/14 only for 1975. Movement data for 24 net counts. (Upstream migrants minus downstream moving fish).

2/ King salmon upstream-downstream movements not documented.

Abundance. The expanded tower count of 162,514 summer chum was the fourth highest count since the project was initiated in 1972; however, this count was only 27% of the record 195 count of 601,880 fish (Table 6). In Appendix Table 2 daily net upstream salmon expanded counts are listed. The 1977 count was substantially higher than either the 1973 parent year of 72 thousand or the 1974 parent year of 108 thousand.

Chum salmon spawners in the Anvik system during 1977 approached 263 thousand including a Yellow River aerial count of 3 thousand (Tables 7 and 8). This was the second year water conditions in the Yellow River allowed a count; but water visibility was still only fair to poor.

In 1976 and 1977, 15-minute counts were recorded at the beginning of each hour. The expanded daily chum salmon count for the season was 105% of the actual count in 1976 and, similarly, was 100.5% of the actual count in 1977 (Appendix Table 3). Thus, the use of a partial hour enumeration would appear quite satisfactory for chum salmon.

Distribution. Spawning distribution of chum salmon for 1977 is presented in Tables 8 and 9. The relative number of spawners above and below the Anvik tower changes from year to year and has ranged from a high of 77% above the tower in 1975 to a low of 34% in 1972 (Table 9). Spawner distribution for 1976 and 1977 was very similar. Distribution (38% below the tower and 62% above) approached the overall average distribution for the years 1972 through 1977. The percentage of escapement in the upper river may increase in years of extremely high escapements.

Comparisons of spawner distribution should take into account the fact that the Yellow River has been surveyed only in 1976 and 1977 and was included with the downstream escapement. Inclusion of escapement between the old and new tower sites in the upstream category was followed for the first time in 1976.

Relative carcass density from area to area and from year to year may be used as an index to relative abundance with reservations. Carcass deposition on bars is to a great extent dependent upon stream flows which are highly variable.

Four thousand yards of beach were surveyed from the area of Beaver Creek to the area of Swift River in 1975. The carcass density was found to be 4.07 chum salmon per linear yard (July 25-August 1). Two thousand yards were surveyed in this stretch of river in 1976 and 1977. The chum carcass count per linear yard was 1.60 and 1.22 for 1976 and 1977, respectively.

Table 6. Historical estimates of Anvik River king and chum salmon escapements, 1958-1977[1/].

Year	Chum salmon tower	Chum salmon Aerial[5/]	King salmon tower	King salmon Aerial[5/]
1977[4/]	163	100[2/]	1,261	79[2/3/]
1976[4/]	237	382[2/]	958[4/]	195[2/3/]
1975	602	845	548	845
1974	201	-	471	-
1973	71	26	517	222
1972	108	209	1,104	414
1971	-	-	-	-
1970	-	233	-	368
1969	-	-	-	296
1968	-	52	-	297
1967	-	116	-	336
1966	-	37	-	638
1965	-	100	-	650
1964	-	13	-	-
1963	-	-	-	-
1962	-	-	-	-
1961	-	21	-	1,226
1960	-	-	-	1,950
1959	-	200	-	350
1958	-	150	-	-
Total	1,382		4,859	
Ave. tower: (6 years)	231		810	

1/ Chum salmon in thousands of fish.
2/ Aerial count in 1976 and 1977 includes Yellow River.
3/ Poor survey.
4/ Count from new tower site.
5/ Aerial counts not made above weir site in 1977.

Table 7. Summary of Anvik River peak salmon escapement counts, 1977.

	King	Chum	Pink	Coho 3/	Total
Tower (expanded)	1,261	162,514	357	-	164,132
Anvik below tower (aerial) 1/2/	39	100,240	-	-	100,279
Boat surveys below tower (kings only)	54	-	-	-	54
Total	1,354	262,754	357	-	264,465

1/ Aerial surveys of lower Anvik and Yellow Rivers generally rated as 50% or less effective for chum salmon. No attempt was made to separately count pink salmon.

2/ Includes Beaver Creek, Yellow River and lower Anvik chum survey of 7-16. Chum tower count was 90% complete by this date. King salmon counts used for the Yellow River and Beaver Creek only.

3/ Coho run not documented during 1977.

4/ King salmon boat survey from weir site to Beaver Creek conducted 7-29; judged to be 50% effective.

Table 8. Anvik River chum salmon escapement distributions as indicated by aerial survey 1975 through 1977.

Stream Location	Chum 1975 No.	1975 %	1976 No.	1976 %	1977 2/ 6/ No.	1977 2/ 6/ %
Below Goblet Creek	6,800	0.8	2,875	0.6	11,800	4.5
Goblet-Beaver	59,425	7.0	48,555	11.1	15,100	5.7
Beaver Creek	19,005	2.3	25,700	5.7	30,500	11.6
Beaver-Yellow River	50,900	6.0	24,475	5.6	26,700	10.1
Yellow River	3/	-	38,680	8.8	3,000	1.1
Yellow River-Robinhood Creek	4/	-	25,200	5.8	12,800	4.8
Robinhood Creek	3/	-	2,830	0.6	400	0.2
Subtotal Lower River	136,130	16.1	168,315	38.0	100,300	38.2
Robinhood Creek-Old Tower Site	4/	-	24,150	5.6	-	-
Yellow River-75 Tower	75,000	8.9	4/	-	-	-
75 Tower-Runkles Creek	4/	-	18,700	4.3	-	-
Runkles Creek-Swift River	4/	-	29,000	6.6	-	-
Swift River	21,545	2.6	38,335	8.7	-	-
Swift River-Otter Creek	4/	-	56,375	12.9	-	-
75 Tower-Otter Creek	345,200	40.9	4/	-	-	-
Otter Creek	47,645	5.6	47,585	10.9	-	-
Canyon Creek	3/	-	3,855	0.9	-	-
Otter Creek-McDonald Creek	215,250	25.5	47,375	10.9	-	-
McDonald Creek	2,470	0.3	4,465	1.0	-	-
Above McDonald	250	-	5/	-	-	-
Subtotal Upper River	707,360	83.9	269,840	62.0	162,500	61.8
Total River	843,490	100.0	438,155	100.0	262.8	100.0

1/ Aerial surveys: 1977 date, 7-16; 7-20, 7-21, 7-21; 1975 date, 7-23.
2/ Counts not representative of actual numbers of king salmon in system.
3/ Not surveyed.
4/ Survey not broken down in this manner.
5/ Fewer than 200 chum.
6/ No aerial survey above 77 weir. Upper river escapement figure weir count only.

Table 9. Chum salmon spawning distributions upstream and downstream of Anvik tower by year.

Year	Aerial count below tower	Percent	Above tower	Percent	Total
1972	137,520	65.9	71,243	34.1	208,763
1973	15,190	58.1	10,966	51.9	26,156
1974 1/	-	-	-	-	-
1975	192,130	22.7	653,355	77.1	845,485
1976	168,315	38.7	267,845	61.3	436,160
1977	100,300	38.2	162,500	61.8	262,800
Total	613,455	34.5	1,165,909	65.5	1,779,364

1/ No count in 1974.

Age, sex, and size composition. The age and sex composition of the Anvik River escapement as indicated by carcass sampling is given in Table 10. Anvik chums were, again, predominantly 4_1 [1/] fish. Sampling was initiated in this system in 1972 and over this 7 year period an average of 62% of fish have been age 4_1. The 1977 Anvik sample of 589 fish was 73% 4_1 and 22% 3_1 salmon. The 1976 chums were predominantly 86% age 5_1 (1971 brood year). The 1973 return, which was the brood year for the 1977 returns, was composed mostly of age 4_1 fish (77%).

Sex composition of 2,445 chum salmon examined in 1977 gave a male to female ratio of 1:2.1 for the second year in which females have dominated. Sex of 3,762 chum salmon carcasses was also determined during beach surveys in 1976, resulting in a male/female ratio of 1:1.6. However, a larger sample of 13,439 carcasses were sexed during 1975 beach surveys with a resulting male/female ratio of 1.1.

In 1977, as in 1975 and 1976 Anvik male chums were significantly longer than Anvik female chum (593 mm versus 548 mm mid-eye to fork of tail). The average length of Anvik chums sampled by year for the years 1973 through 1977, males and females combined, was respectively 552, 565, 577, and 584 mm. These lengths were not statistically compared due to within sample variability associated with sexual and year class differences.

Table 10. Age and sex composition of 1977 chum salmon sampled by post-spawning crew surveys, Anvik River, 1977.

	Male		Female		Total	
Age [1/]	No.	%	No.	%	No.	%
3_1	20	3.4	111	18.9	131	22.2
4_1	161	27.3	270	45.8	431	73.2
5_1	7	1.2	15	2.6	22	3.7
6_1	3	0.5	2	0.3	5	0.8
Total	191	32.4	398	67.6	589	100.0

1/ Gilbert-Rich Formula - Total years of life at maturity (large type) - year of life at outmigration from fresh water (subscript).

King salmon

Timing. The first king salmon in 1977 was observed at the tower site on June 26. A peak daily count of 137 individuals was obtained on July 14 (Appendix Table 2). A similar peak of 135 kings passed the tower site on July 18. Ninety-five percent of the run passed the tower by July 25 (Appendix Table 4).

Migration timing as shown in Figure 9 during 1977 was generally intermediate between that of a very late year (1975) and an early year (1974). The 95% level of counts was not reached until July 28 in 1975, 1 day prior to termination of counting. King salmon movement past the tower in 1974 began early (6-24) and had peaked by July 15. High water took out the weir on July 19 of 1974 leaving the last stages of the run undocumented. Some in-migration undoubtedly occurred after the termination of the 1977 study, but is believed to have been minor.

Hourly distribution of counts for the standard 18-hour count period is shown in Figure 10 for 1974-1977. This measurement of movement is expressed as the percent of total seasonal migration to pass the counting tower in a given hour of the day. Migration peaked at 1500 through 1800 hours in 1977 and at 1400 hours in 1976. Two peaks at 0500 and 1400 hours occurred in 1975. The highest counts in 1972 and 1974 occurred between the hours of 1300 and 1700. Based on 24-hour counts conducted in 1973, 1976, and 1977 (combined data) the lowest continuous 6-hour period of king salmon movement is from 2[illegible]-0500 accounting for 13.3% of movement. The best "compromise" time period to omit from the counting schedule is from 0300 to 0900 when 17% of kings were counted. Data presented by Baxter (1976) for the Holitna weir and tower total king salmon counts shows the low 6-hour migration period to be from 2400 through 0600; counts peaked between 1400 and 2000.

The king salmon 15-minute count for 1977 expanded to 105.7% of the actual seasonal count and is considered a good correlation (Appendix Table 3).

King salmon downstream movement has averaged 14.3% of upstream movement for the 4 years for which such data is available.

Abundance. The 1977 tower expanded count of 1,261 kings was the highest since the project was initiated in 1972. The 1972 count was next highest at 1,104.

The escapement estimate of Anvik system kings in 1975, 1976, and 1977 is comprised of the upper river weir, lower river float, and Beaver

Figure 9. Comparison of daily migration patterns for king salmon, Anvik River, 1974-1977.

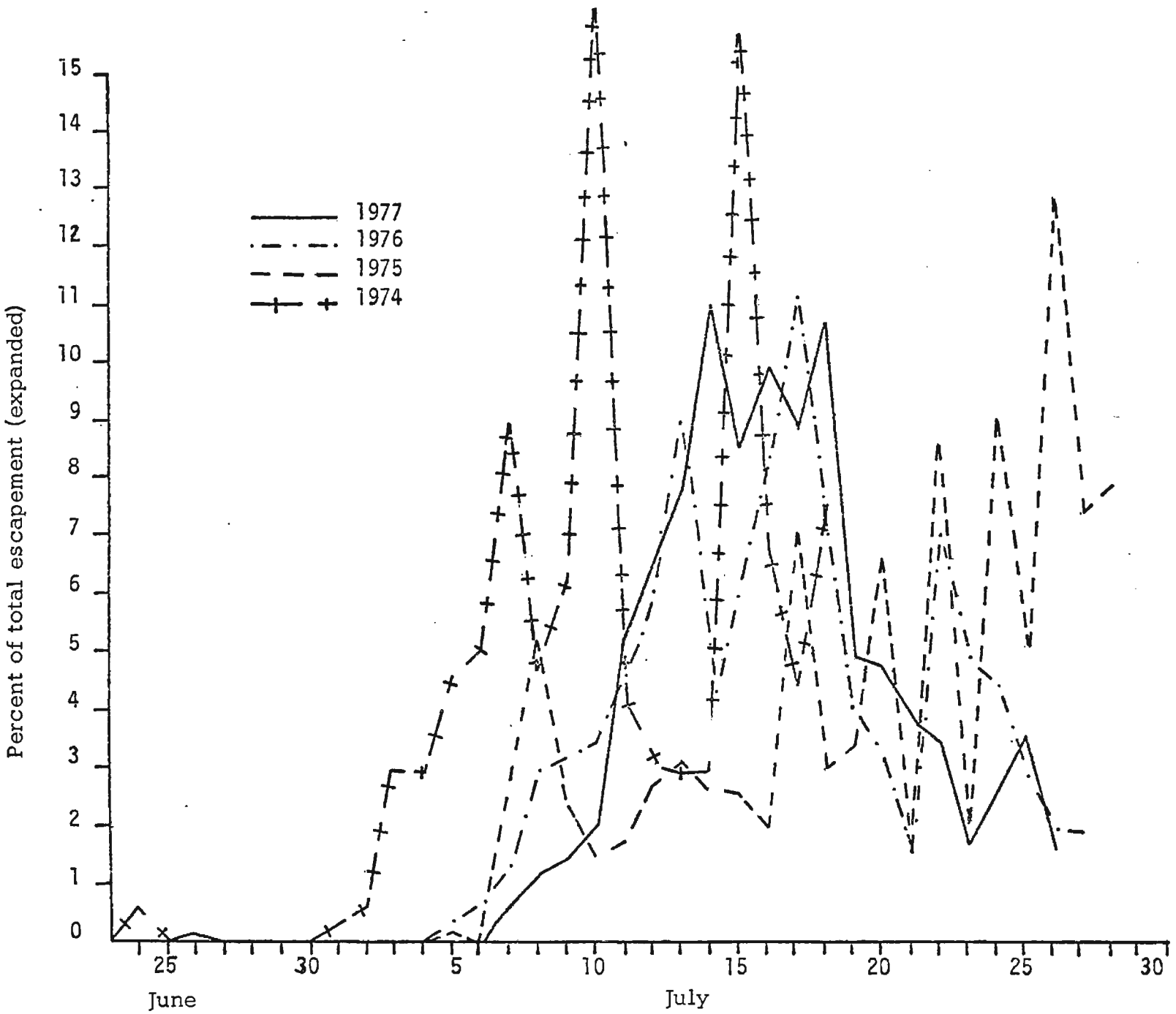
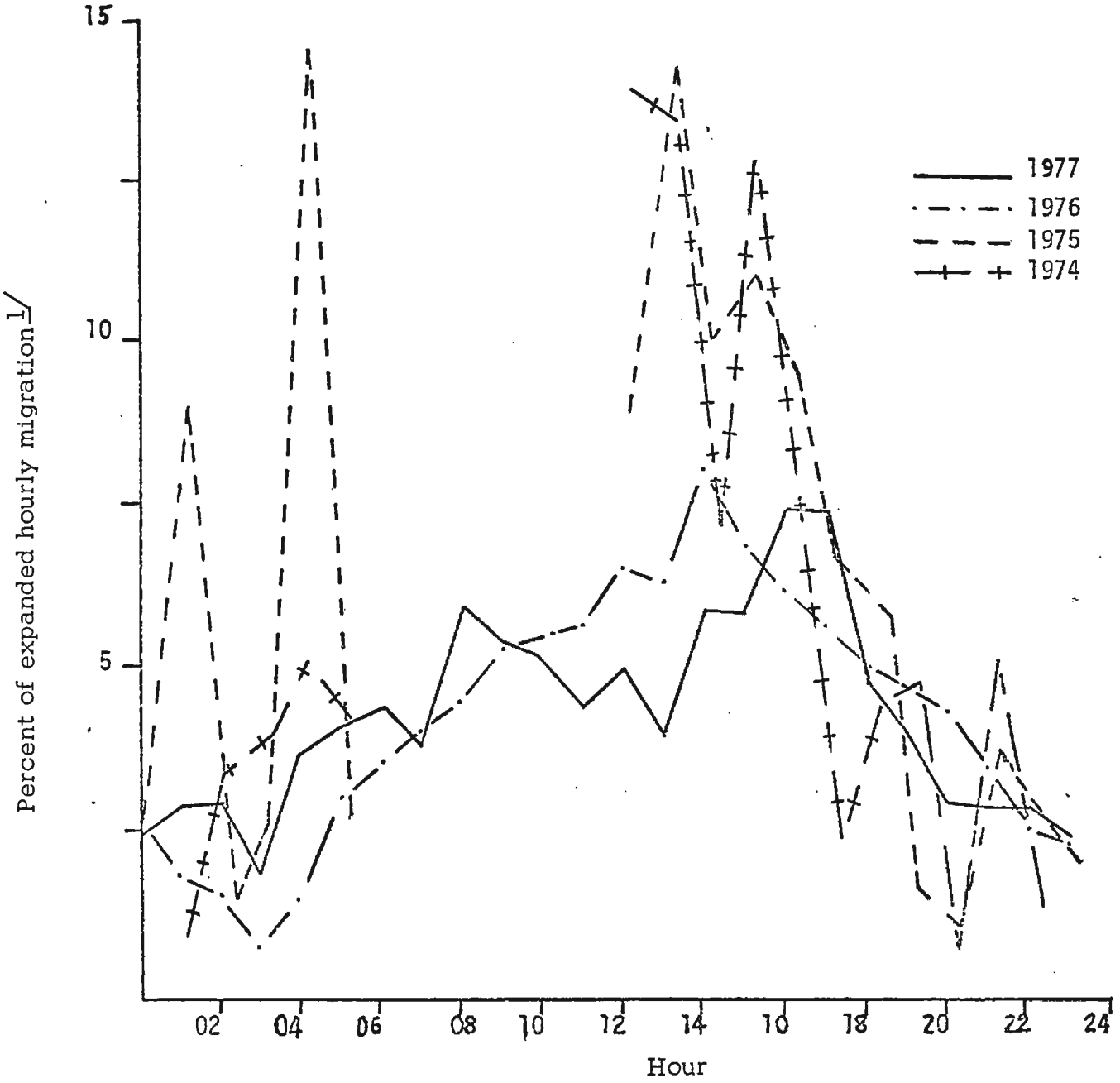


Figure 10. Comparison of hourly migration patterns for king salmon, Anvik River, 1974-1977.



1/ Based on expanded 18 hour percent.

Creek aerial survey estimates (respective totals of 730, 1,155, and 1,354 fish). The 1976 estimate included 93 Yellow River kings and a survey of this river in 1977 under poor conditions gave a count of 32 kings.

Distribution. One hundred twenty-three kings were counted during a boat survey on July 28, 1976 from the old tower site to the new tower site (Robinhood Creek); a distance of about 3 miles. In 1977, 114 kings were counted on this same stretch by boat survey (Table 11). Fifty-four kings were counted on the river stretch from the Robinhood Creek weir to Beaver Creek on a July 29 boat survey. The survey was judged 50% effective. Tower counts prior to 1976 would not have included kings spawning in these river sections.

Most king salmon spawning within the main Anvik and tributaries (with the exception of Yellow River) is believed to occur upstream of the Robinhood Creek tower site (Mauney 1977). Relatively few king salmon have been observed in the major upstream tributaries.

Age, sex, and size composition. Few king salmon carcasses were sampled to determine age, sex, and size composition of the Anvik River run prior to the 1976 field season. Carcasses of this species do not become readily available until the first week in August. A carcass sampling crew remained on the Anvik into mid-August to collect king salmon data in 1976 and again in 1977.

Age and sex were determined for 116 king carcasses in 1977. Numbers of male and female fish in the sample were essentially equal (Table 12). The predominant age was 6_2 which represented 64% of kings examined; age 5_2 fish represented 28% of samples. Only forty-five carcasses could be found for examination in 1976 and of these 73% were male. Age 6_2 fish comprised 20% of kings examined. The 1977 Flat Island gillnet test fishing catch of 109 kings average 70% age 6_2, 25% 5_2, and 3% 7_2. Sex ratios of the Flat Island catch were biased in favor of females, totaling 59% (Geiger and Andersen 1977). Gillnets are known to be size selective for larger fish in mesh sizes fished and female kings generally average a larger size than do males.

There was good correlation between the frequencies of size categories from carcass samples and those estimated from tower observations in 1977 (Table 13). Carcass samples were 54% over 800 mm and 41% 601-800 mm; tower estimates ran 49% and 38% for the same respective size categories.

Table 11. Anvik River observed king salmon escapement distributions as indicated by survey 1975, 1976, and 1977 1/ 2/.

Stream location	1975 2/ No.	1975 2/ Percent	1976 2/ No.	1976 2/ Percent	1977 2/ No.	1977 2/ Percent 3/
Below Goblet Creek	-	-	0	0.0	2	
Goblet-Beaver	4/	-	1	0.5		No aerial surveys conducted above tower so percent distribution not meaningful.
Beaver Creek	1	0.4	0	0.0	15	
Beaver-Yellow River	3	1.4	1	0.5	16	
Yellow River	3/	-	93	47.7	32	
Subtotal Lower River	4	1.8	95	48.7	65	
Yellow River-Robinhood Cr.	4/	-	0	0.0	3	
Robinhood Creek	3/	-	0	0.0	3	
Robinhood Creek-Old Tower Site	4/	-	14	7.2	114	
Yellow River-75 Tower	24	10.8	4/	-	3	
75 Tower-Runkles Creek	4/	-	1	0.5	3	
Runkles Creek-Swift River	4/	-	26	13.3	14	
Swift River	3	1.4	2	1.0	3	
Swift River-Otter Creek	4/	-	25	12.8	9	
75 Tower-Otter Creek	120	55.0	4/	-	3	
Otter Creek	1		2	1.0	3	
Canyon Creek	3/	-	0	0.0	3	
Otter Creek-McDonald Cr.	70	31.5	30	15.4	3	
McDonald Creek	0	0.0	0	0.0	3	
Above McDonald	0	0.0	0	0.0	3	
Totals	222	100.0	195	100.0	235	-

1/ Aerial surveys: 1977, 7-16; 1976 dates, 7-16, 7-20, 7-21, 7-21; 1975 date, 7-23.
2/ Counts not representative of actual numbers of king salmon in system.
3/ Not surveyed.
4/ Survey not broken down in this manner.
5/ Fewer than 200 chum.
6/ No aerial survey above weir site 77 survey by boat. Date of boat surveys 7-23 and 7-29.

Table 12. Age and sex composition from carcass sampling of 1977 Anvik River king salmon scale samples[1].

Age[2]	Male		Female		Total	
	No.	Percent	No.	Percent	No.	Percent
4_2	2	1.7	1	0.9	3	2.6
5_2	27	23.1	6	5.1	33	28.2
6_2	27	23.1	48	41.0	75	64.1
7_2	2	1.7	4	3.4	6	5.1
Total	58	49.6	59	50.4	117	100.0

1/ King salmon carcasses collected in the time period of August 1-12.
2/ Counts not representative of actual numbers of king salmon in system.

Table 13. Estimated size frequencies of king salmon migrating upstream past the Anvik River tower, 1973-1977.

Tower year	Estimated Size[1]									
	Under 500 mm		501-600 mm		601-800 mm		800 mm		Total	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent
1973	19	4.1	46	9.7	112	23.6	297	62.6	474	100
1974	5	1.4	123	34.4	150	41.9	80	22.3	358	100
1975[2]	16	7.1	59	26.1	80	35.4	71	31.4	226	100
1976[2]	3	12.0	359	39.0	336	37.0	105	12.0	911	100
1977	29	2.4	128	10.7	448	37.5	593	49.4	1196	100
Carcasses										
1976[3]	1	2.0	8	16.0	33	66.0	8	16.0	50	100
1977	3	3.0	2	2.0	48	41.0	63	54.0	116	100

1/ Total length.
2/ Does not include salmon seen but not clearly discernable.
3/ Lengths mideye to fork of tail.

Based on major brood year tower counts, escapements were good in 1972 (1,104 fish) and fair in 1973 (517 fish). The king salmon harvest in the Yukon was relatively large in 1972 and was low in 1973. If freshwater and marine survival rates for the 1972 brood year are normal, a high rate of return would be expected for 1978.

Pink salmon

An expanded total of 357 pink salmon was counted past the Anvik tower during 1977 (Appendix Table 2). A record high of 1,366 pink salmon was counted in 1975. Pink salmon tower counts for 1973 and 1974 were 286 and 197 respectively. The low period of pink salmon migration appeared to be between the hours of 0600 and 1200 when 20% of the movement occurred during observations.

Coho salmon

Aerial surveys were not made of Anvik River coho escapement in 1977. A local resident took approximately 200 coho for subsistence from the upper Anvik during the fall of 1978.

Juvenile salmon

Beach seining operations begun in late July 1975 revealed the presence of juvenile king and coho salmon in riffle and pool areas near the tower site and LaVoie's cabin. Beach seining was continued in 1976 and 1977. Average lengths of juvenile kings by date of capture in 1977 were 7/3, 43 mm; and 7/19, 63 mm (Table 14).

Table 14. Length analysis by species of juvenile salmon taken by seine, Anvik River-Robinhood Creek site, July 1977 1/.

Species	Date	n	x	Range	Age
King	7/3	7	43.2	39.2 - 53.0	0 (1)
King	7/19	17	63.1	43.5 - 70.0	0 (1)
Coho	7/18	2	68.5	64.0 - 73.0	0 (1)

1/ Measurements by total length.

Acoustic Side Scan Salmon Counter

Bendix Electrodynamics Division, in conjunction with the Alaska Department of Fish and Game, has been developing acoustic adult salmon and smolt counters since 1964. The latest technological development has been the Bendix redesign of existing acoustic fish enumeration systems to produce a single transducer and salmon counter. The side scanner has been described in detail by Menin (1976).

A side scanning unit was field tested at the Robinhood Creek site for a second field season in 1977. Installation of the unit began on July 1. An artificial substrate was used which consisted of a hydrodynamically modified 8-inch pipe 58-feet long over which the acoustic beam was directed. A housing on the inshore surface of the artificial substrate was designed to hold the transducer securely. The transducer beam was directed along the surface of the substrate to a metal target located at the opposite end of the substrate. Adjustments of the transducer beam direction proved to be a major difficulty.

By July 3 adequate numbers of chum salmon were moving up the river for basic calibration to be completed and satisfactory test counts made. Daily comparisons of side scanner and visual counts began on July 4 and continued through July 16 (Table 15). For the first 9 days, a 92.3% correlation was achieved between acoustic and visual chum salmon counts; by 7/13 spawning activity in the vicinity of the artificial substrate had increased to the point that the accuracy of acoustic counts had dropped significantly. Efforts were made to drive spawners away from the artificial substrate with little lasting success.

Several king salmon were observed passing over the artificial substrate. Acoustic king counts ran from 41 to 400% of actual visual counts averaging 132% and 90% for the side scan sonar velocity settings 0.387 and 0.45 sec /feet, respectively (Table 16). The tendency was for the side counter to overcount kings at the 0.387 sec/ft velocity setting which assumed relatively fast swimming by the fish of 2.58 ft/sec. Conversely, assuming a lower swimming speed of 2.22 ft/sec with a velocity setting of 0.45 sec/ft the side scanner tended to undercount kings. The side scanner does not distinguish between king and chum salmon in counting.

Selecting optimum velocity settings throughout the test period presented some problems. The water velocity over the artificial substrate fluctuated continually as the water level fell making it necessary to change the side scanner velocity setting throughout the test. Swimming speed for chum salmon was originally assumed to be that found for sockeye or approximately 2 feet per second and the side scanner was set to count targets

Table 15. Side scanner versus visual chum salmon counts, Anvik Tower, 1977 1/2/.

Date	Visual count	Sonar	Percent accuracy	Velocity settings (sec/ft)
7/ 4	1,122	1,468	76.0	.45
7/ 5	3,055	3,099	98.2	.45
7/ 6	4,141	4,586	89.7	.45
7/ 7	8,837	9,817	89.1	.45
7/ 8	6,369	7,414	84.0	.45
7/ 9	14,173	15,304	88.5	.387
7/10	17,906	17,236	98.6	.45
7/11	13,374	12,183	93.8	.39, .34
7/12	19,032	20,807	91.0	.365, .387
Subtotal	88,009	91,994	93.2	
7/13	11,938	15,171	77.7	.365, .387
7/14	12,249	15,054	79.8	.42
7/15	8,102	11,761	66.4	.45
7/16	7,709	10,767	67.7	.45
Subtotal	39,997	52,753	73.7	
Total	128,006	144,747	86.1	

1/ Net upstream visual counts used.
2/ Al Menin 1976.

Table 16. King salmon counts by Anvik side scanner, 1977.

Date	No. of king salmon	No. of counts	Percent counting	Velocity (sec/ft)
7/14	7	17	24	.387
7/14	14	14	100	.387
7/14	3	1	33	.387
7/14	4	5	125	.387
7/15	2	4	200	.45
7/16	6	5	83	.45
7/16	4	4	100	.45
7/16	2	1	50	.45
7/17	8	9	113	.45
7/18	6	4	67	.45
7/19	4	1	25	.45
7/20	3	3	100	.45
7/21	3	2	67	.45
7/21	1	2	200	.45
Total	67	72	107	
Total at .387	28	37	132	
Total at .45	39	35	90	

1/ Velocity setting given as sec/ft or reciprocal of ft/sec. Feet per second equivalent: 0.387 sec/ft = 2.58 ft/sec; 0.45 sec/ft = 2.2 ft/sec.

passing at this speed. Swimming speed settings were later modified to approximately 2.2 feet per second.

The dropping water level also affected the active range over which the alternate 2° and 4° transducer beams could be used. At the Robinhood Creek site the water column depth during 1977 studies was very shallow for side scanner use. When the beam touches the water surface, false counts occur. To correct the situation the active range of the beam was decreased until no surface counts occurred; finally the active range was shortened to 25 feet. Additional weiring was installed to force the fish over the active portion of the substrate.

Chum carcasses floating or bouncing over the artificial substrates yielded occasional counts on the acoustic system. Counting error due to four non-salmon species of fish being counted during the Anvik 1977 test was believed minimal.

Seven different individuals made the visual counts from the Anvik tower. Comparative counts run over the same time period by two or more individuals showed good correlation in counting between the individuals with counting differences generally of less than 10%.

Summary

The 1977 Anvik tower site was just upstream from the mouth of Robinhood Creek. This site, a shallow riffle area, has proven to be ideal for weir installation and counting tower operation. Water conditions throughout most of the 1977 counting season were extremely low and generally very clear.

The first chum salmon observed passing the Robinhood Creek tower site in 1977 was on June 29. Ninety-eight percent of the chum salmon run had passed by July 21.

Based on 24-hour counts, the time of least movement for chum salmon was between 0600 AM and 1200 Noon.

The expanded Anvik tower count of 162,514 summer chum ranks fourth since the project was initiated in 1972. The total river observed count in 1977, including the Yellow River, was 262,754 chums.

In 1977, 62% of the chum escapement observed during aerial surveys was above Robinhood Creek with 38% below.

Carcass sampling for a second year, indicated that in 1977 there was a preponderance of females to males of 2 to 1, respectively. Carcass sampling of chums in 1976 indicated a ratio of females to males of 1.6 to 1.

Age class 4_1 chums dominated escapements from 1973 through 1975 and comprised 73% of the 589 carcasses sampled in 1977.

The first king salmon observed at the counting tower was on June 26 in 1977. Ninety-five percent of the king salmon migration, as indicated by counts, had passed the tower by July 25. Timing of the 1977 run was normal.

Based on 24-hour counts, the lowest continuous 6-hour period of king salmon movement was from 2300-0500 (13.3% of daily migration observed).

The total Anvik River king count in 1977, including the Yellow River was 1,354 fish. Most of the observed king salmon spawning occurred within the main Anvik River above Robinhood Creek and the Yellow River.

The sex ratio of 116 king salmon carcasses examined in 1977 was essentially equal. The predominant age class represented was 6_2 at 64%. Fifty-four percent of king carcasses measured were in the above 800 mm category; similarly, 49% of kings observed from the tower and size categorized were of this size.

MID-YUKON FALL TAGGING

Introduction

As part of a statewide stock separation study, additional state funds became available July 1, 1976 to conduct a 3-year tag-recovery program of Yukon River fall chum salmon. The objectives have been as follows:

1. Determine the timing of separate stocks through the fishery.
2. Determine the pathways of movement of separate stocks through the fishery.
3. Determine the relative contribution of major spawning stocks to the fishery.
4. Estimate population size and exploitation rate of the major stocks.

Materials and Methods

Fishwheels were rented on contract from fishermen. Fishwheels rented in 1977 were of the standard large Yukon design. Fishwheel number 1 was fished along the north bank (River mile 555, Galena north) upstream from Galena. Fishwheel number 2 was fished along the south bank (River mile 540, Galena south) upstream from Galena. Fishwheel number 3 was fished along the south bank (River mile 601; Ruby, south) approximately 20 miles upstream of Ruby.

Tagging was initiated at the Galena north bank wheel August 5 and at the Galena south bank wheel August 6. Tagging was terminated on September 17, and on September 21 at north and south bank sites, respectively. The first day of tagging at the Ruby site was August 10 with tagging terminated on September 30. To allow ready field separation as to tagging location, north bank tags were odd-numbered, south bank tags were even-numbered, with a few exceptions.

Base camps were established within the immediate vicinity of each fishwheel. Communication was maintained between camps by radio. As the season progressed, daily fishwheel catches were used by management personnel as an index to run strength in making decisions regarding fishing season openings upriver. Communication of catches to headquarters was accomplished by telephone from Galena.

Detailed tagging procedures and recovery operations were listed in the 1976 Annual Technical Report (Maunary 1977). Numbers of other fish species in fishwheel catches were recorded by date of capture. Tag recovery efforts were undertaken in the Sheenjek, Toklat, Delta, and Fishing Branch Rivers (Figure 11). Tags were recovered from carcasses or from spawning fish retrieved by means of spear or shotgun. Spawning ground observations included: (1) the ratio of tagged to untagged fish, (2) tag recoveries by date, and (3) air and water conditions and temperatures.

Carcasses and living fish were sampled in the Sheenjek, Fishing Branch, Toklat, and Delta areas throughout the period of on-site investigations. Data taken included sex and length (mideye to fork of tail). Scale and tissue samples were taken for later reading and analysis.

Analysis of the 1977 data has been completed and will be detailed below. Data from earlier studies conducted in 1972 and 1973 have been organized and presented also in a special tagging report (Mauney 1979). A summary of earlier Yukon tagging projects was also presented in the 1974-1977 Completion Report (Mauney 1977).

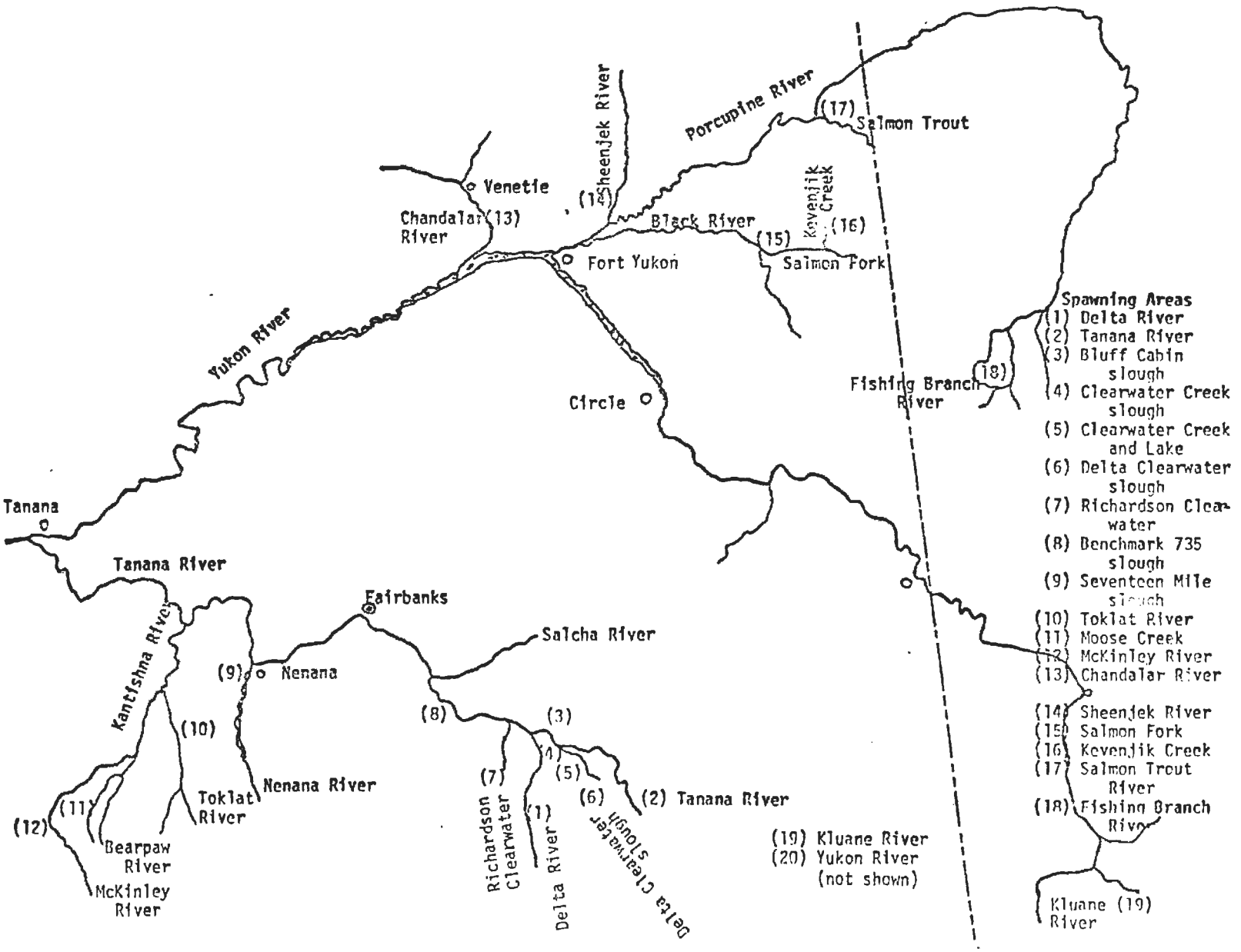


Figure 11. Tanana and upper Yukon fall chum salmon spawning areas, 1977.

Results and Discussion

Catches and tagging

A total of 5,358 chum salmon was tagged in 1977. A breakdown of chum tagged by location indicated that 1,841 (34%) were tagged at Galena north bank, 1,208 (23%) were tagged at Galena south bank, and 2,309 (43%) were tagged at the Ruby site (Table 17 and Appendix Table 5). This gave a total of 3,517 (66%) chums tagged along the south bank of the Yukon. The Ruby bank site was more productive for both chum and coho than the Galena south bank site. Catch is dependent on site location and the number and proximity of other fishwheels immediately downstream. This latter is probably a major factor in the Galena area where most productive sites are heavily fished. Two other wheels were operated throughout most of the 1976 and 1977 runs within 200 yards downstream of the wheel at the south bank tagging site. Comparisons of catch per unit effort between fishwheels at various locations to give an indication of run abundance may, therefore, be very imprecise. Project fishwheel catch success, subsistence catch levels, escapements, and the trends of commercial harvests indicated that the 1977 fall chums were more abundant than in 1976. Numbers of chums tagged at the Galena wheels in 1977 increased substantially over 1976 levels. North bank or Galena No. 1 tagging increased overall by 325% over 1976 levels; the Galena No. 2 south bank tagging rate increased by 186%. It is believed that tagging was conducted over most of the fall run in both years.

Eighty percent of the chums had been tagged at Galena north by August 30, Galena south by September 16, and Ruby south by September 1[illegible] (Appendix Table 5 and Figure 12). Peak catches by date and fishwheel [illegible]e: 146, August 24; 74, August 24; and 165, August 27 for wheels 1, 2, [illegible] 3, respectively. The 1977 chum run appeared earlier at project sites and peaked earlier than did the 1976 run. Tagging peaked at the north bank site on August 30 and at the south bank site on September 1 in 1976.

The percentage of males tagged was greater than females for both years at all tagging sites. Percent tagged in 1976 was 55 and 56 for the south and north banks, respectively. Respective figures for 1977 were 61 and 59%.

Length data for chum salmon by sex and fishwheel of tagging has been examined (Table 18) and no really meaningful difference in length of fish in respect to location of tagging was noted in 1977.

Seventy-five percent of Galena fishwheel number one tagged chum aged in 1977 were 4_1 age fish. Ruby chums were also predominantly 4_1

Table 17. Total numbers of salmon tagged by species and location, 1976 and 1977.

		1976	1977	Total
Chum				
Wheel 1	Galena N.	545	1,841	2,386
2	Galena S.	672	1,208	1,880
3	Ruby S.	0	2,309	2,309
	Total	1,217	5,358	6,575
Coho				
Wheel 1	Galena N.	9	12	17
2	Galena S.	5	9	14
3	Ruby S.	0	207	207
	Total	14	228	242

Table 18. Comparative chum salmon lengths for fishwheel sites by year of tagging 1/.

	Site	1976 n	Mean length	1977 n	Mean length
Male	Galena north	312	599	1,077	666
	Galena south	383	548	761	659
	Ruby south	-	-	1,397	664
Female	Galena north	244	564	647	626
	Galena south	296	538	447	618
	Ruby south	-	-	892	621

1/ Lengths in mm tip of snout to fork of tail.

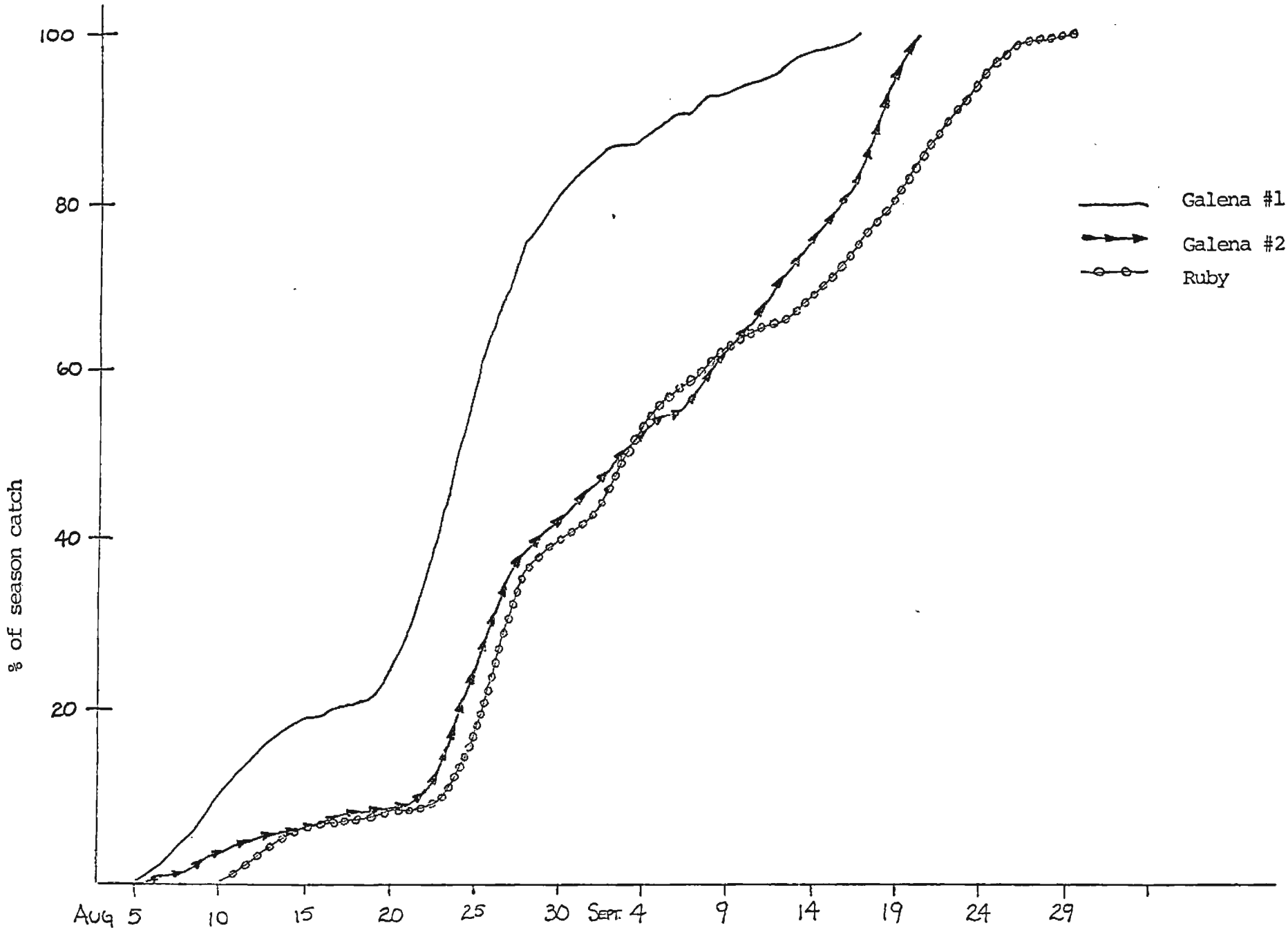


Figure 12. Comparative run timing of fall chums by the Galena and Ruby fishwheels as shown by cumulative daily catches, 1977.

fish (68%). The Ruby tagging site catches were higher in 3_1 age chums than were those of the Galena north bank site, 36 and 6%, respectively. Scale samples taken from spawning ground chum sampled also showed age 4_1 fish as predominant in 1977. The percentage of 4_1's ranged from 65% in the Fishing Branch to 88% in the Delta (Geiger and Andersen 1977). Spawning ground samples of fall chum in 1976 showed Sheenjek samples to run 53% age 5_1 and Toklat samples to run 52% age 4_1 with age 3_1 chums also strongly represented at the latter location (42%).

Two hundred and twenty-eight coho were also tagged in 1977, a preponderance, (91%) were tagged at the Ruby site (Appendix Table 6). Percent of total coho tagged for sites 1 and 2 ran 5.3 and 4.0%, respectively.

Eighty percent of coho caught by project fishwheel were caught by September 15. The peak coho daily catch was 21 on September 3. Approximately 67% of those tagged were males (total of 152). In 1976 only 14 coho were tagged.

Project fishwheel catches of non-salmon fish species are presented in Appendix Table 7.

Rate of tag returns by tagging site, recovery site, year, and sex

Recoveries of 1977 chum tags through September of 1978 were 1,990 or 37% of those at large. Percent recovery by location of tagging for Galena north, Galena south, and Ruby south has run respectively 45, 35, and 32%. Recoveries of north bank tags have run higher than would be expected; recoveries of Ruby south bank tags have run lower than would be expected (Appendix Table 8). Actual and expected numbers of returns of south bank tagged Galena chums in 1977 were similar. By contrast in 1976, Galena north bank chum were recovered at a lower rate than would have been expected while Galena south bank chum were recovered at a higher than expected rate.

This difference in the rate of observed and expected returns by site of tagging may be explained in part by differences in the allocation of fishing effort and run strength. Fishermen from the village of Tanana fished, with increased catch success, an apparently larger, upper Yukon run in 1977 as compared to the 1976 run. This village accounted for approximately 20% of all tag returns in 1976 and approximately 24% in 1977. Tanana Village moved to first place in ranking of numbers of tag returns in 1977; Ruby was first in tag returns in 1976 and second in relative ranking for 1977 (Figure 13).

No difference has been observed in the numbers of observed and expected male and female tagged chum recovered for either 1976 or 1977 (Appendix Table 8).

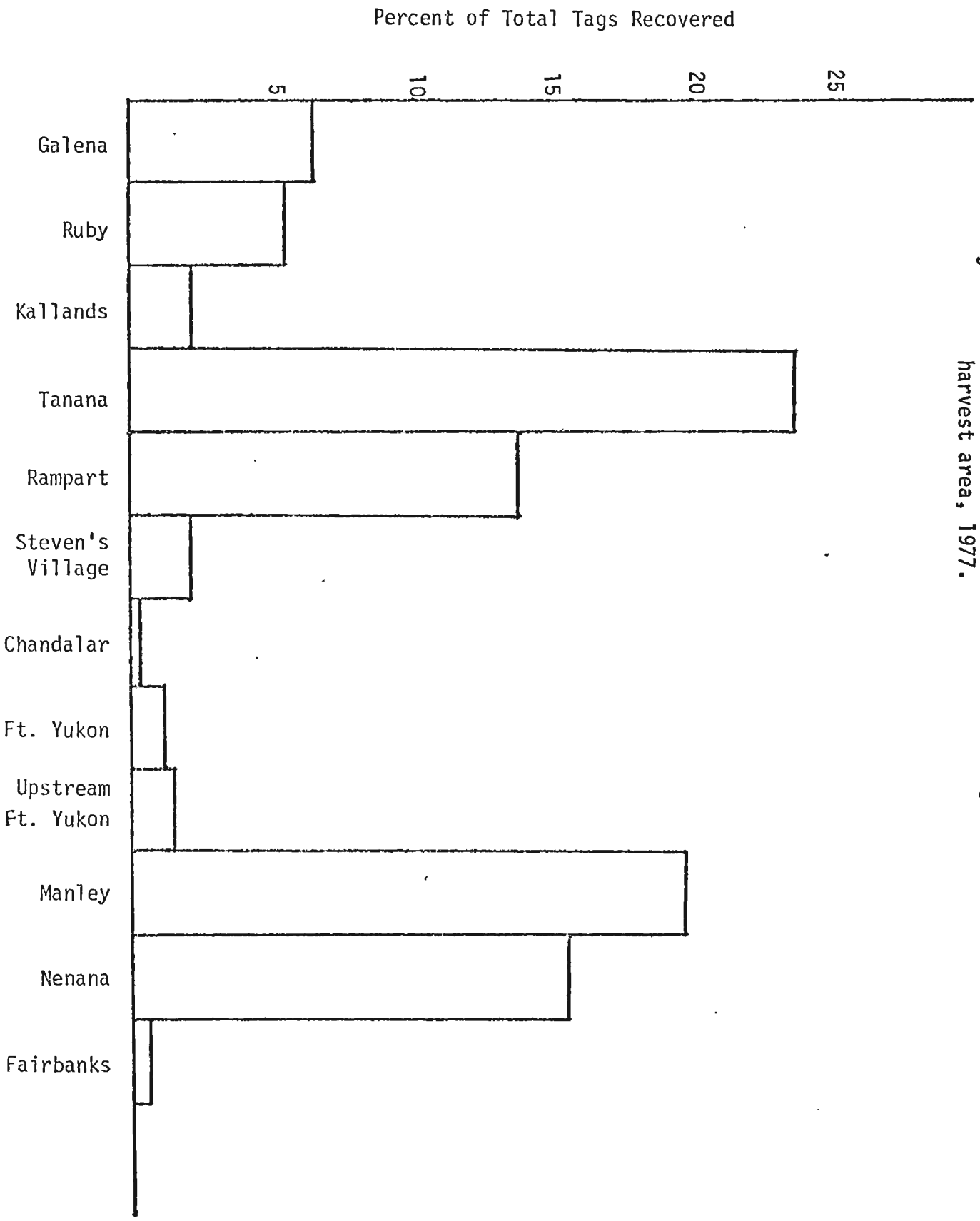


Figure 13. Percent of total Yukon chum salmon tag recoveries by major harvest area, 1977.

A total of 51 or 22% of the coho tagged in 1977 have been recovered to date. The percent recovery for this species in 1976 was 42% (6 out of 14 tagged). Recoveries by sex were 38 male and 13 female. There would appear to be a selective rate of recovery for males.

Tag returns by method of recovery and fishing activity

Returns by fishing activity and year indicate that the commercial fishery accounted for 62% of recoveries in 1976 and 30% in 1977 (Table 19). Subsistence fisheries accounted for 30% of recovered tagged chum in 1976 and 56% in 1977. The Board of Fisheries imposed limit of 250 thousand commercial fall chum in 1976 was not easily reached by the fishery due to the small size of the run. Most of the chum catch was, therefore, sold commercially. The substantially stronger 1977 run resulted in commercial quotas being quickly attained. A larger percentage of the 1977 harvest thus was utilized in the satisfaction of subsistence needs. Subsistence caught salmon eggs could be legally sold in 1977. This sale possibly resulted in motivating some individuals to catch salmon in excess of their actual needs.

Table 19. Numbers of tagged chum salmon recovered by activity and year.

	Activity										
	Unknown		Commercial		Subsistence		Sport Spawning G.				Total
Year	No.	%	No.	%	No.	%	No.	%	No.	%	No. %
1976	16	2.8	376	61.8	185	30.4			31	5.1	
1977	146	7.5	594	30.4	1100	56.4	3	0.2	108	5.5	
1976 & 1977	162	6.3	970	37.9	1285	50.2	3	0.1	139	5.4	100

Tag recoveries of chum salmon by gear type are presented in Table 20. There was little difference between years in the relative importance of the major harvest gears in the capture of tagged salmon for 1976 and 1977. Gillnets accounted for 23% of the recoveries; fishwheels accounted for 69% of recoveries. The fishwheel is the primary gear used in upper Yukon fisheries. Spawning ground recoveries, made by and large by Fish and Game crews, accounted for 5.4% of recoveries.

Table 20. Numbers of tagged salmon recovered by gear by year.

			Gear					
		Unknown	Beach seine	Drift gillnet	Set gillnet	Fishwheel	Spawning ground	Total
1976	No.	24	0	0	153	400	31	608
	%	3.9	0	0	25.2	65.8	5.1	100
1977	No.	64	4	3	429	1384	107	1991
	%	4.6	0.2	0.2	21.6	69.5	5.4	100
1977 & 1976	No.	88	4	3	582	1784	138	2599
	%	3.3	0.2	0.1	22.4	67.4	5.3	100

Tagged coho recoveries followed in general the same pattern seen for chum recoveries.

Stock separation by pathways of migration

The numbers of fall chum recoveries by river mile and by major area of recovery for 1977 are given in Appendix Table 9. These recoveries have been further examined in combination with 1976 returns. Primarily the combined data will be discussed.

The main Yukon below Tanana has accounted for 953 or 36% of the 2,590 1976 and 1977 tags recovered to date. Approximately 41% of the recoveries were tagged originally at the Galena north bank wheel, 39% were originally tagged at the Galena south bank wheel, and 20% were tagged at the Ruby south bank wheel. The Ruby wheel site is above the major Ruby fishery which accounted for 27% of 1976 recoveries.

For purposes of analysis, salmon recovered above Yukon River mile 695 are regarded as upper Yukon River stocks. Salmon recovered above Tanana River mile 695 are regarded as Tanana River stocks. Only tag returns thus identified as to major spawning destination are presented in Table 21, which shows that 76% of chum tagged at Galena fishwheel number one on the north bank in 1976 and recovered above the Tanana confluence were recovered in upper Yukon areas; 94% of chum tag recoveries for this site in 1977 were in upper Yukon areas. Overall for both years, 92% of the recoveries from the Galena north bank site and identified as to major river system were recovered in the upper Yukon. Eighty-seven percent of the

Table 21. Yukon chum tag recoveries by bank of tagging, river mile, and year.

	North Bank				South Bank			
	1976		1977		1976		1977	
	No.	%	No.	%	No.	%	No.	%
Location				Yukon				
Downstream Rampart Rapids	5	5	84	15	3	2	5	2
Rampart Rapids	10	10	90	32	2	1	6	2
Rampart Village	38	39	151	25	8	5	8	3
Hess Creek	11	11	29	5	1	.5	7	3
Stevens Village	3	3	38	7.0	1	.5	5	2
Beaver	0	0	0	0	3	2	0	0
Ft. Yukon	2	2	16	2.9	0	0	2	1
Circle	2	2	2	0.4	0	0	0	0
Woodchopper	0		5	0.4	0	0	0	0
Eagle	1	1	12	2.0	1	.5	0	0
Dawson City	1	1	12	1.7	0	0	0	0
Chandalar	2	2	4	0.6	0	0	0	0
Porcupine	0		5	0.9	0	0	0	0
Sheenjek	0		3	0.6	0	0	1	.5
Fishing Branch	1	1	1	0.1	1	0.5	0	0
Subtotal	76	76	553	94	24	24	34	6
				Tanana				
Lower Tanana	0	0	0	0	0	0	2	1
Manley Hot Spgs	9	9	11	2.0	52	31	110	44
Kantishna R.	12	12	0	0	58	35	4	2
Minto	0	0	2	0.4	0	0	4	2
Nenana	0	0	14	3.0	0	0	61	24
Wood River	0	0	1	0.1	3	2	0	0
Fairbanks	0	0	0	0	3	2	1	.5
Upstream Fairbanks	0	0	0	0	0	0	1	.5
Toklat	1	1	2	0.4	27	16	30	12
Delta	0	0	0	0	1	0.5	3	1
Subtotal	22	13	30	12	144	87	216	88

chums tagged at the Galena south bank site and recovered for 1976 and 86 and 88% tagged and recovered in 1977 were recovered in the Tanana system. A total of 250 Ruby south bank tagged chums were recovered in 1977 in the upper Yukon or Tanana. Two-hundred and sixteen of these or approximately 86% were recovered in the Tanana system.

For practical management considerations, based on the 1976 and 1977 tagging at Galena and at Ruby, it appears that chum salmon migrating up the north bank of the Yukon from the Galena area upstream can be regarded as upper Yukon stocks; chum salmon migrating up the south bank of the Yukon from the Galena area upstream can be regarded as Tanana stocks. Further, based on the Ruby and Galena south percentage returns in the Tanana of 93 and 87%, respectively, bank separation appears to become more distinct further upstream.

The separation of Yukon and Tanana stocks by north and south bank at time of tagging is shown in Figure 14. The important Toklat River spawning grounds produced 110 recoveries of which 107 (97.3%) were originally tagged at south bank sites.

Recoveries by major spawning areas over both years are presented in Table 22.

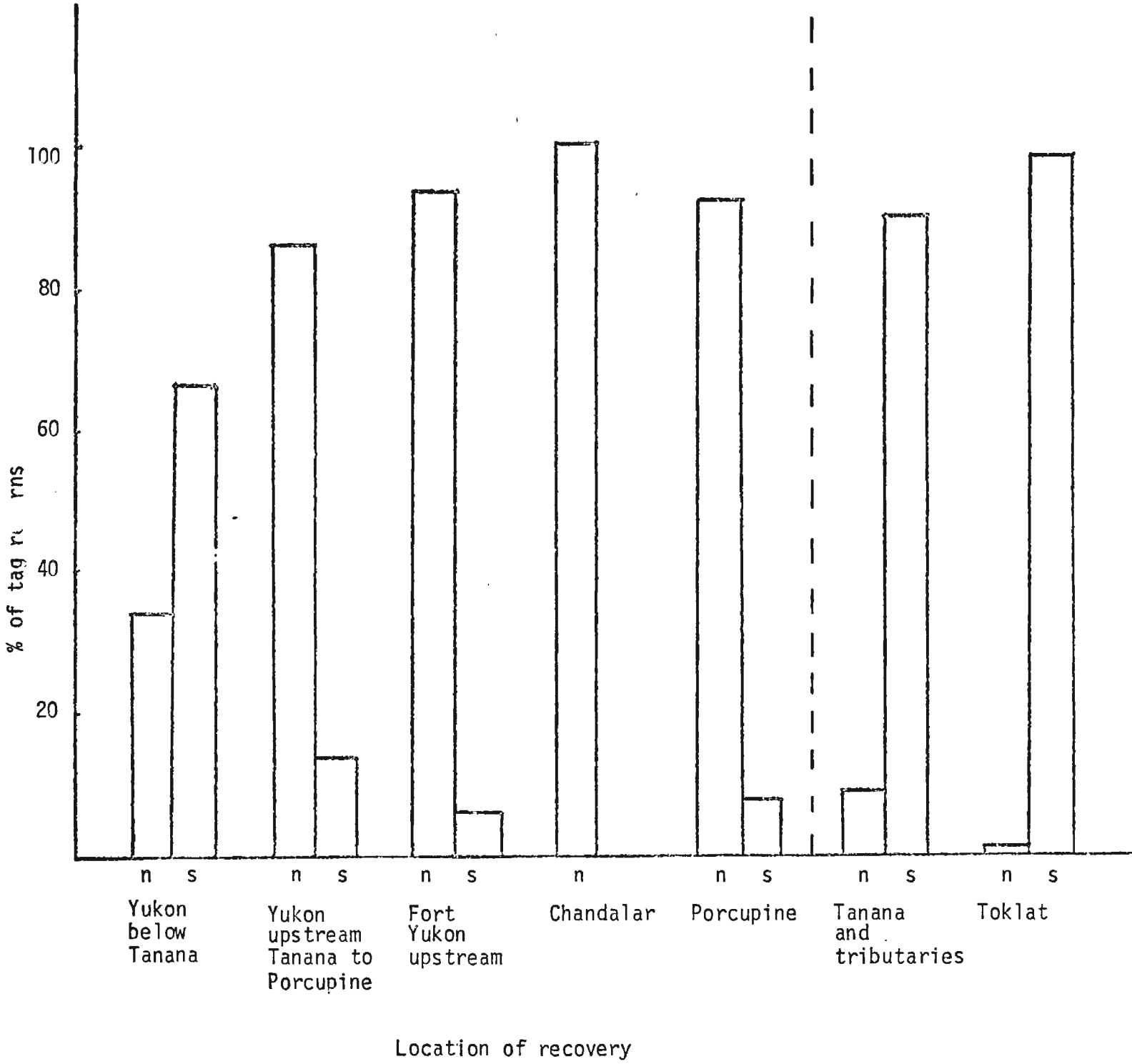
Table 22. Tag recoveries by spawning areas, 1976 and 1977.

Spawning grounds	No. recoveries	Total escapements in thousands	Ratio 1/
Chandalar	6	5	1.2
Toklat	110	62	1.8
Fishing Branch	3	46	0.07
Delta	20	23	0.9
Sheenjek	3	33	0.09

1/ Ratio: Number tagged salmon recovered/thousand spawners estimated.

The lack of tag recoveries from Sheenjek and Fishing Branch spawning grounds could be attributed to a number of factors: 1) Failure to initially tag these stocks at the same ratio due to different migration pathways such as along midriver sandbar, 2) selective downstream fishing mortality downstream removed a higher percentage of the tagged upper Yukon stocks leaving relatively fewer tagged fish to escape. (This is especially true since small

Figure 14. Percent of tag returns from 1977 fall chum by bank of tagging and major river area.



numbers of salmon were tagged. After running the gauntlet of the main Yukon fisheries 2,955 tagged chums remained in the Tanana at the Kantishna River confluence; only 841 of the upper Yukon tagged chum still survived upon reaching the Porcupine confluence, 3) failure to spot tagged salmon during recovery efforts, 4) differential predation of tagged fish before recovery, and 5) twice as many chums were tagged on the south bank as on the north.

Most documented coho spawning in the upper Yukon drainage has been within Tanana tributaries. Coho catches by project fishwheels seemed to show that most coho followed the south bank. Tag returns supports this with 86% of tagged coho recovered (51 recoveries) coming from the Tanana system. Returns thus indicate that coho as well as chum become bank oriented well downstream from the Tanana confluence. Low catches of coho at the Galena south bank site with high catches at the Ruby south bank site indicates that salmon migratory patterns in respect to proximity to the bank may alter from one river location to another.

Run timing

According to the observations of Galena area fishermen, the north bank catches generally peak earlier than south bank catches. This pattern was verified in the 1976 tagging effort. Tagging and tag return data for 1976 and 1977 were combined in a computer analysis to see if differences in run timing for discrete stocks could be detected.

Tag recoveries by date of tagging and location of recovery were expressed as a percentage of total season tag recoveries for fishwheels 1, 2, and 3, respectively. This data shows the pattern of passage of salmon runs by a tagging site through time. Runs were identified by location of tag recoveries. As an example, for fishwheel No. 1 tagging Rampart rapids recovery location, a total of 119 or 64% of recoveries came from chums tagged in the 11 days from August 21 through 31.

On the basis of existing data the temporal identification of specific spawning ground stocks at fishwheel sites does not appear possible, however, by lumping Tanana and upper Yukon stocks, distinctive temporal patterns for major drainage systems can be seen. Seventy percent of Galena north tags recovered in the upper Yukon were tagged between August 21 and September 5. Seventy-two percent of Galena south tags recovered in the Tanana were tagged at this site between August 25 and September 12. The period of peak chum migration past the Ruby site has been shown to be much longer. Seventy-two percent of the Tanana tags recovered, which were tagged at fishwheel No. 3, were tagged at this site between August 24 and September 18.

Run timing has been summarized in graphic form in Figure 15 by fishwheel tagging site. It can be seen that Galena north run timing, identified as largely upper Yukon by recoveries in the upper Yukon, peaked August 23, the earliest of the three sites. Ruby fishwheel No. 3 has shown two similar high peaks on August 25 and 27. Tanana runs by the Galena south No. 2 identified by recoveries in the Tanana peaked on September 1. The indicated temporal separation of Tanana and upper Yukon stocks peaks by Galena wheels No. 1 and would be approximately 9 days.

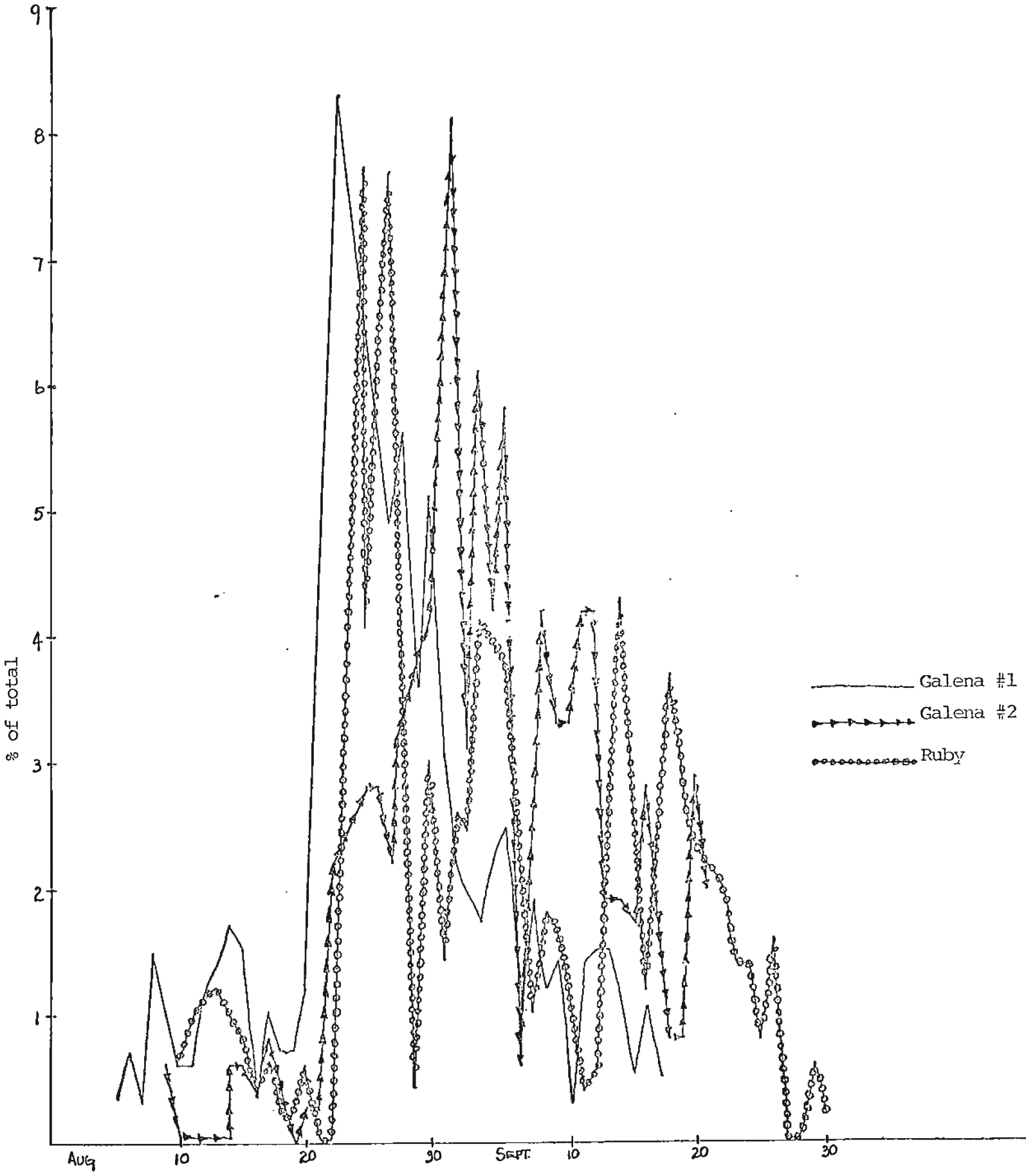
Rate of Yukon chum salmon migration has variously been determined to be 21 miles/day by Trasky (1971), 13.7 to 18.2 miles/day by Rampart studies (1972, 1973), and 13.7 to 16.2 miles/day in the 1976 and 1977 mid-Yukon studies. Perhaps the most realistic estimate of actual swimming rates developed to date is based on 23 chum salmon tagged at Galena tagging wheel 2 and recovered by the Ruby tagging wheel (61 miles upstream). The average rate of travel was 21.6 miles/day; nine individuals covered the distance between wheels at the rate of 30.5 miles/day. The average time at large for 1,560 chums tagged and recovered during 1976 and 1977, was 15.5 days; the average distance traveled for these fish was 197 miles (Appendix Table 10 and 11).

The timing of passage for fall chum stocks destined to the upper Yukon and Tanana systems by the Galena north (No. 1), Galena south (No. 2) and Ruby south (No. 3) sites as indicated by tag returns is presented in Figure 16. Eighty percent of the upper Yukon stocks had passed the Galena north site by September 2; 80% of Tanana stocks had passed the Galena south wheel by September 11; 80% run of Tanana stocks had passed the Ruby south wheel by September 16.

On the basis of data available upper Yukon and Tanana stocks appear to move upriver by the Galena tagging sites as temporally distinct and identifiable runs. The bulk of the upper Yukon run may have passed the Galena area as much as 9 days prior to the passage of a corresponding level in the Tanana run. Little difference was seen in the timing of peak runs by the Galena north bank and Ruby sites. Relative timing of runs, however, has been demonstrated to fluctuate rather widely between years; this makes an average date of passage for north bank and south bank runs of questionable value in practical fisheries management.

Fall chum salmon entering lower Yukon fisheries would appear, from test fishing data, to exhibit more pronounced and distinct peaks than in the upstream fisheries (Figure 17). It is likely that these high peaks in abundance are modified by the cropping effect of the fisheries. The correlation of peaks in run abundance for the lower Yukon and mid-Yukon would appear to be very difficult to make on the basis of existing data.

Figure 15. Comparative run timing of fall salmon by the Galena and Ruby fishwheels as indicated by daily tag returns in river areas of harvest for 1976 and 1977.



Based on recoveries in the Tanana for wheels 2 and 3 and the upper Yukon for wheel 1.

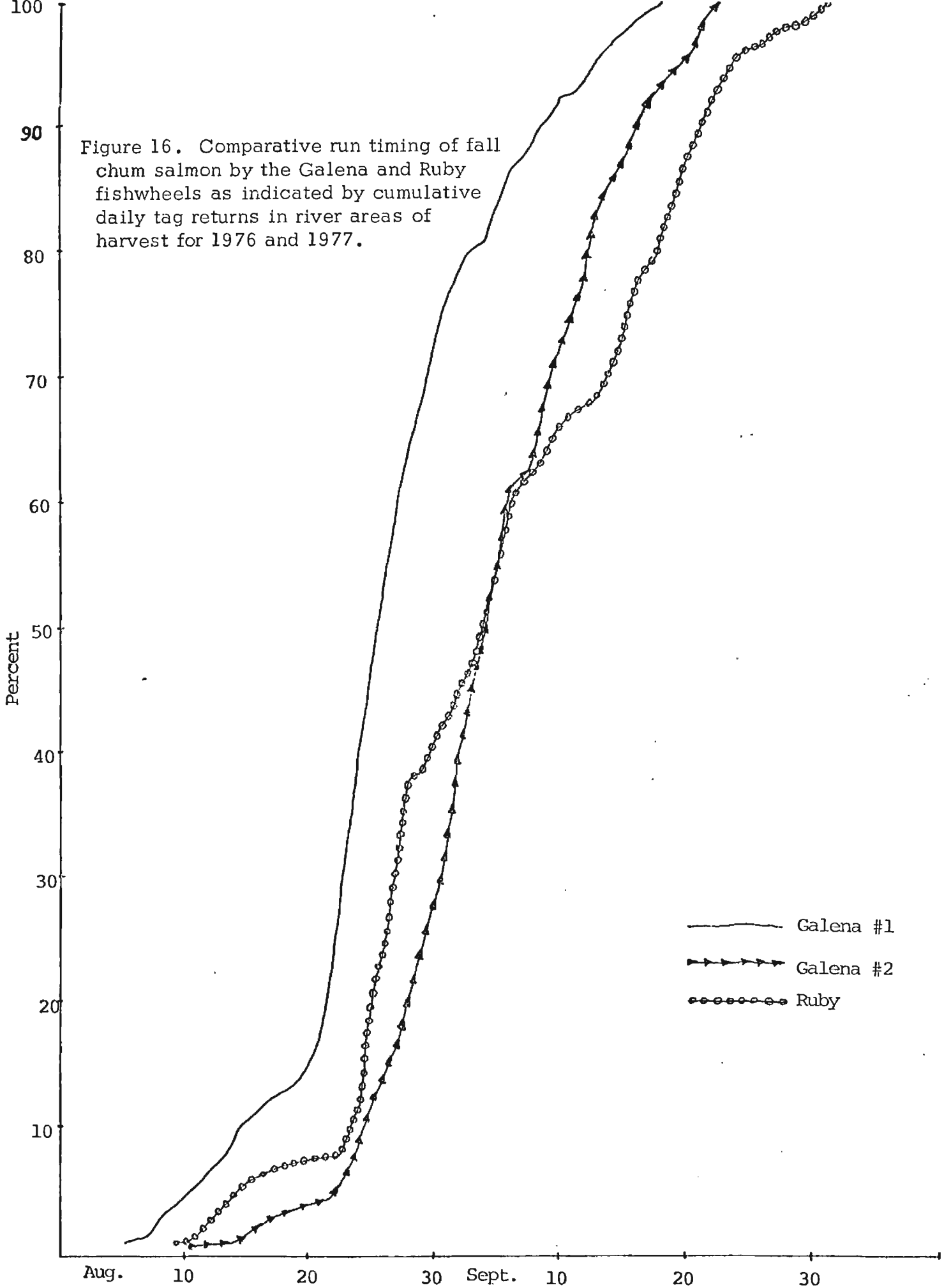
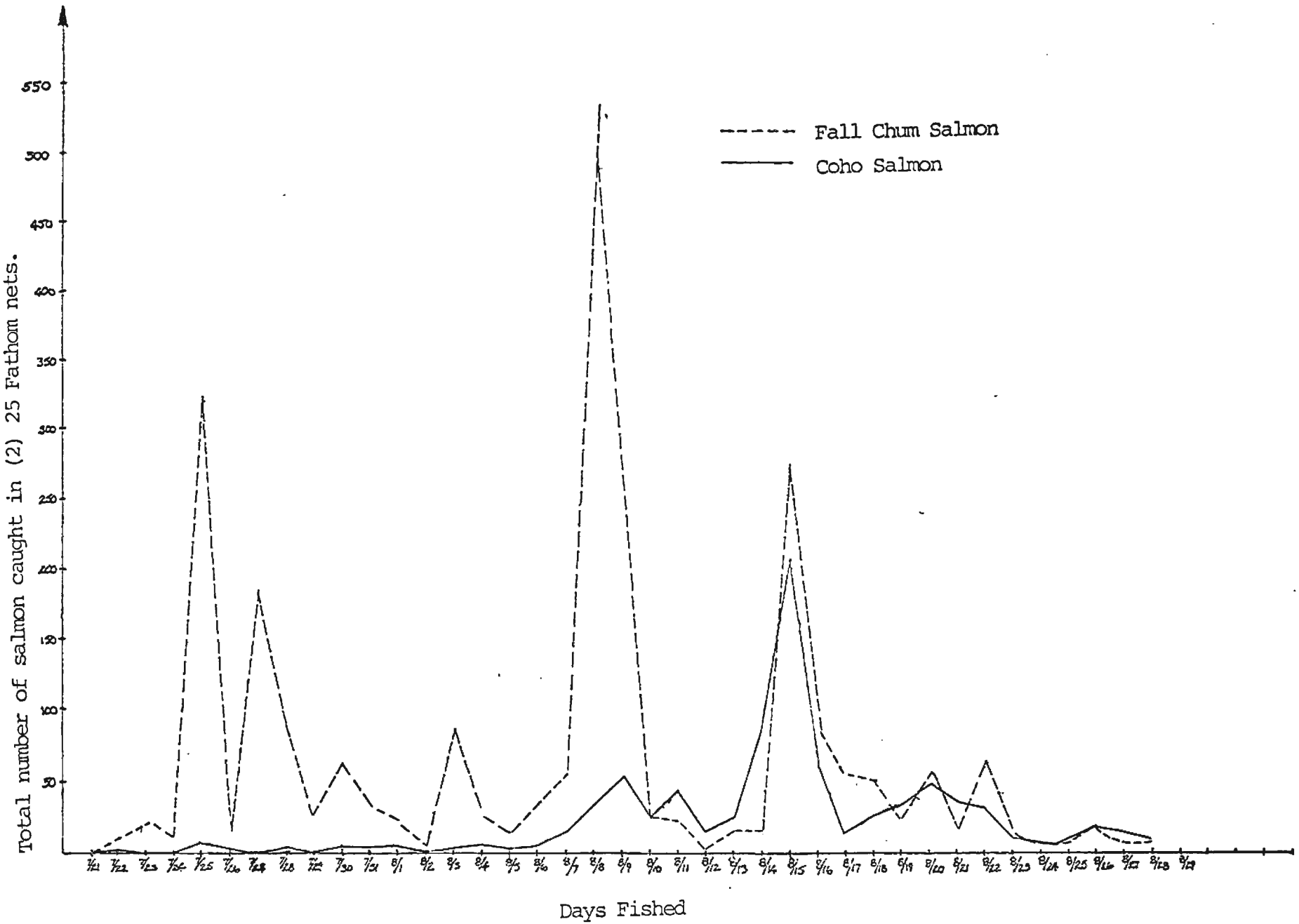


Figure 16. Comparative run timing of fall chum salmon by the Galena and Ruby fishwheels as indicated by cumulative daily tag returns in river areas of harvest for 1976 and 1977.

Based on recoveries in Tanana for wheels 2 and 3 and in the upper Yukon for wheel 1.

Figure 17. Chum and coho salmon run timing at Big Eddy, Yukon River, 1977.



1) Alaska Department of Fish and Game test fishing 24 hours a day.

Population estimation

Hayes and Sears (1962) estimated the fall chum population above Rampart to be 131,000 in 1962. The best index available to total fall chum abundance in the Yukon system for 1974 and 1975 combines observed escapement and commercial and subsistence harvests and was, respectively, 492 and 971 thousand (Mauney 1976).

A simple Petersen population estimate of 149 thousand fall chums was made for the upper Yukon, above Galena, based on the 1976 tagging and harvest (see Mauney 1978 for model of computations). A high rate of fall chum exploitation of 51% by the upstream fisheries was indicated. An exploitation rate of 76% of the entire Yukon River fall chum salmon run, including the lower Yukon harvest, was found for 1976 (Appendix Table 12).

Petersen estimate of population size for the 1977 fall chum run is presented in Appendix Table 13. The estimation for the upper Yukon (above Galena) and Tanana combined was approximately 288 thousand and the rate of exploitation for this population was 37%. For the entire Yukon the 1977 population estimate was 513 thousand and rate of exploitation was 65%.

Observed escapement in 1977 totaled to 116,000 fish. The sum of total harvest and escapement for this year was 71 thousand short of the calculated total population level.

Surveys of the upper Kluane River area by staff personnel in late October found that there were several thousand spawning chum in this area. Other areas of potentially substantial, undocumented populations include the Minor Branch of the Porcupine, the White, and the Black Rivers.

A simple Petersen population estimate was made of the Tanana fall chum population from salmon tagged at Galena wheel number 1 and recovered at the Ruby wheel number 3. The population estimate was 115 thousand chums. The Tanana system known harvest and escapement for 1977 totals was 117 thousand fish.

The 1977 return of fall chums was substantially above that expected. Based only on parent year (1974) strength, the 1978 return of fall chums to the Yukon should be above average exceeding 500 thousand.

Summary

Fall chum and coho salmon were captured by fishwheels and tagged upstream of Galena at River mile 555 on the north bank of the Yukon and at

River mile 540 on the south bank of the Yukon in 1976 and again in 1977. An additional tagging wheel was operated in 1977 upstream of Ruby at River mile 601.

Tagging was initiated at the Galena north bank wheel on August 5 and terminated at the Ruby south wheel on September 30 in 1977. Initial tagging in 1976 was on August 10 and termination was on September 17. The 80% run level for 1977 as indicated by numbers of chum tagged was reached on August 30, fishwheel 1; September 15, fishwheel 2; and September 19, fishwheel 3. In 1976 the 80% level of chums tagged was reached on August 31 and September 3 for wheels 1 and 2, respectively. The 80% run level for coho tagged in 1977 was reached on September 16.

Within the Tanana system, the Manley fishery has accounted for 42%, and Nenana 33% of chums tagged at the Galena south site; for the Ruby south site recoveries in the Tanana system have been 51% Manley and 29% Nenana.

The main harvest areas and corresponding percent of returned tags in the upper Yukon include: Rampart Rapids (31%), Rampart Village (29%), Hess Creek (7%), and Stevens Village (7%).

For 1976 and 1977 data combined 62% of chum tagged have been male and 38% have been female. No difference has been observed in the numbers of observed and expected returns by sex.

Approximately 67% of coho tagged in 1977 were males. Males have accounted for the disproportionate 77% of recoveries for this species.

Fall chums were predominately 4_1 in age in 1977 ranging from a high of 88% for Delta spawning ground samples to a low of 65% for Fishing Branch samples. Spawning ground samples in 1976 showed ages 5_1 and 3_1 to be well represented comprising 53 and 42% of Sheenjek and Toklat samples respectively.

Recoveries of tagged salmon by recovery activity for 1976 and 1977 combined were 38% commercial, 50% subsistence, and 5% spawning grounds. Recoveries by gear, years combined, were 23% set gillnets, 69% fishwheel, and 5% spawning grounds.

For the years 1976 and 1977 combined an average of 94% of the Galena north bank tag recoveries identified as to drainage destination were recovered within the upper Yukon above the Tanana confluence. Tag recoveries from Galena south and Ruby ran 86 and 94% for identified Tanana recoveries over this 2-year period.

Combined spawning ground recoveries for both years are: Chandalar 6, Sheenjek 6, Fishing Branch 3, Toklat 110, and Delta 20. Toklat recoveries have been 97% of south bank tagging origin.

An average swimming rate of 21.6 miles/day was found for fall chums in 1977. A significant number of chums were shown to migrate up to 30 miles/day.

On the basis of tag return data upper Yukon and Tanana stocks appear to pass through the Galena tagging areas at different times. Combined 1976 and 1977 data indicated that 80% of upper Yukon stocks had passed by the Galena north wheel by September 2; the 80% run level of Tanana stocks by the Galena south wheel was reached on September 11.

Forty-four percent of the coho recovered in 1977 were from the Tanana system. Coho recovery below the Tanana-Yukon confluence totaled seven fish.

Population estimates of Yukon stocks were made using the 1972 and 1977 tagging studies. The simple Petersen method was used to estimate total numbers in the upper Yukon and Tanana. Total drainage populations were also derived by adding lower river harvests to the upper river estimates as a check on the Petersen estimates and were in basic agreement.

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APPENDIX

Appendix Table 1. Anvik River tower chum salmon cumulative immigration percentage by date (expanded count) for years 1973-1977.

Date	1977	1976	1975	1974	1973
6-23					
24				0.6	
25				1.4	
26				2.8	
27				4.1	0.1
28				5.5	
29				7.6	0.9
30		0.1		10.4	2.5
7- 1		0.4		14.0	5.7
2		2.2		18.1	11.0
3	0.4	2.9		23.5	19.1
4	1.1	3.2		30.9	26.1
5	3.1	10.9		37.2	31.7
6	6.5	18.3	1.7	44.1	36.5
7	11.9	37.7	4.5	49.5	38.8
8	19.0	53.5	7.6	54.2	42.8
9	29.2	63.8	15.0	58.9	50.8
10	40.8	69.8	23.4	65.6	58.4
11	53.7	77.0	29.3	69.2	69.1
12	65.3	81.4	37.7	73.4	75.4
13	72.5	86.6	46.8	79.3	80.4
14	79.8	89.2	58.1	87.0	84.4
15	85.5	90.8	66.9	94.1	87.6
16	89.9	92.7	75.7	96.4	89.4
17	92.5	94.3	81.9	97.6	92.2
18	95.5	95.5	86.9	99.4	94.3
19	96.5	97.3	90.2	100.0	95.5
20	97.3	98.0	93.0		96.3
21	98.0	98.5	95.3		97.2
22	98.8	99.0	96.7		98.0
23	99.0	97.8	97.8		98.3
24	99.1	99.6	98.8		98.6
25	99.5	99.8	99.3		98.9
26	100.0	99.9	99.7		99.0
27		100.0	100.0		100.0

Appendix Table 2. Daily net upstream salmon counts (expanded), Anvik River tower, 1977.

Date	King Number	%	Chum Number	%	Pink Number	%
6-26	1	0.1	0	0	0	0
27	0	0	0	0	0	0
28	0	0	0	0	0	0
29	0	0	2	-	0	0
30	0	0	22	-	0	0
7-1	0	0	4	-	0	0
2	0	0	31	-	0	0
3	0	0	526	0.4	0	0
4	0	0	1,274	0.8	0	0
5	0	0	3,163	1.9	0	0
6	4	0.3	5,556	3.4	1	0.3
7	6	0.5	8,837	5.4	2	0.6
8	15	1.2	11,679	7.2	6	2.5
9	18	1.4	16,515	10.1	10	2.8
10	25	2.0	18,843	11.5	16	4.5
11	66	5.2	21,019	12.9	25	7.0
12	81	6.4	18,934	11.5	13	3.6
13	98	7.8	11,796	7.2	10	2.8
14	137	10.9	11,948	7.2	15	4.2
15	107	8.5	9,262	5.7	30	8.4
16	125	9.9	7,202	4.4	17	4.8
17	113	9.0	4,204	2.6	22	6.2
18	135	10.7	4,818	2.9	13	3.6
19	62	4.9	1,679	1.0	27	7.6
20	59	4.7	1,365	0.9	20	5.6
21	48	3.8	1,093	0.7	18	5.0
22	41	3.3	1,201	0.7	38	10.6
23	21	1.7	409	0.2	18	5.0
24	34	2.7	466	0.2	21	5.9
25	44	3.5	383	0.2	16	4.5
26	21	1.1	283	0.2	19	5.3
Total	1,261	100	162,514	100	357	100

Appendix Table 3. Evaluation of fifteen minute counts as an index to hourly counts, Anvik Tower, 1977[1/].

Date	Daily total of 15 minute counts	15 minute counts expanded to hourly	Daily total of hourly counts	% 15 minute hourly
		Chum Salmon		
7-2	6	24	15	160
3	85	340	354	96
4	262	1,048	1,159	90
5	726	2,904	3,040	96
6	1,430	5,720	5,556	103
7	1,430	5,720	8,837	65
8	2,987	11,948	11,679	102
9	3,970	15,880	16,515	96
10	4,751	19,004	18,843	101
11	5,257	21,028	21,019	100
12	4,731	18,924	18,934	100
13	3,021	12,084	11,796	102
14	3,245	12,980	11,948	109
15	2,011	8,044	7,715	104
16	2,023	8,092	7,202	112
17	1,111	4,444	4,204	106
18	1,411	5,644	4,813	117
19	505	2,020	1,679	120
20	428	1,712	1,365	125
21	290	1,160	1,093	106
22	161	644	674	96
23	64	256	272	94
24	89	356	353	100
25	56	224	290	77
26	49	196	214	92
Total	40,099	160,396	159,574	100.5
		King Salmon		
7-11	19	76	66	115
12	9	36	81	44
13	23	92	98	94
14	39	156	137	114
15	24	96	87	110
16	37	148	125	118
17	28	112	113	99
18	39	156	135	116
19	14	56	62	90
20	13	52	59	88
21	15	60	48	125
22	5	20	28	71
23	4	16	15	107
24	12	48	28	171
25	10	40	36	111
26	9	36	17	212
Total	300	1,200	1,135	105.7

1/ Net upstream counts. Total of 15 minute counts for season downstream.

Appendix Table 4. Anvik River king salmon cumulative immigration percentage by date (expanded count) for years 1973-1977.

Date	1977	1976	1975	1974	1973
6-24				0.6	
6-25				-	
6-26	0.1			-	
6-27	0.1			-	
6-28	0.1			-	0.1
6-29	0.1			-	0
6-30	0.1			-	0
7-1	0.1			0.9	0.5
7-2	0.1			1.5	1.0
7-3	0.1			4.4	1.9
7-4	0.1			7.3	2.5
7-5	0.1	0.3		11.9	3.6
7-6	0.4	1.0	0.1	16.9	3.9
7-7	0.9	2.3	0.1	25.7	5.1
7-8	2.1	5.3	3.1	30.3	7.9
7-9	3.5	8.5	8.2	36.4	11.8
7-10	5.5	12.0	10.6	52.5	16.3
7-11	10.7	16.6	12.0	56.6	21.1
7-12	17.1	22.7	13.7	59.8	26.0
7-13	24.9	31.5	16.4	62.7	30.5
7-14	35.8	35.8	19.5	65.6	35.2
7-15	44.3	42.1	22.1	81.3	37.7
7-16	54.2	50.1	24.6	88.0	45.9
7-17	63.1	61.3	26.6	92.4	55.8
7-18	73.8	68.4	33.6	100.0	62.5
7-19	78.7	72.4	36.5		69.2
7-20	83.4	75.5	39.8		75.5
7-21	87.2	77.0	46.4		81.9
7-22	90.5	84.0	48.1		88.7
7-23	92.1	88.8	56.6		90.5
7-24	94.8	93.2	58.6		90.6
7-25	98.3	96.0	67.0		90.6
7-26	100.0	97.9	72.1		91.8
7-27		99.8	84.9		98.4
7-28		100.0	92.2		99.5
7-29		100.0			100.0
7-30					
7-31					
8-1					

Appendix Table 5. Numbers of chum salmon tagged by wheel and date.

Date	1977 Wheel No. 1 No.	%	Wheel No. 2 No.	%	Wheel No. 3 No.	%
Aug 5	8	0.4				
6	26	1.8	2	0.2		
7	27	3.3	8	0.8		
8	33	5.1	5	1.2		
9	49	7.8	16	2.6		
10	46	10.3	3	2.8	12	0.5
11	36	12.2	15	4.0	22	1.5
12	36	14.2	11	5.0	36	3.0
13	37	16.2	6	5.5	24	4.1
14	30	17.8	7	6.0	24	5.1
15	22	19.0	4	6.4	27	6.3
16	11	19.6	5	6.8	15	6.9
17	12	20.2	3	7.0	11	7.4
18	11	20.8	-	-	3	7.5
19	19	21.9	2	7.2	4	7.7
20	41	24.1	13	7.4	9	8.1
21	81	28.5	10	8.3	7	8.4
22	111	34.5	22	10.1	6	8.7
23	134	41.8	39	13.3	29	9.9
24	146	49.7	74	19.4	70	13.0
25	129	56.7	60	24.4	110	17.7
26	125	63.5	57	29.1	132	23.5
27	112	69.6	62	34.2	165	30.6
28	95	74.8	48	38.2	139	36.6
29	52	77.6	35	41.1	38	38.3
30	51	80.3	17	42.5	51	40.5
31	47	82.9	20	44.1	25	41.6
Sep 1	31	84.6	34	46.9	50	43.7
2	33	86.4	22	48.8	67	46.6
3	10	86.9	35	51.7	79	50.1
4	17	87.8	19	53.2	72	53.2
5	36	89.8	19	54.8	72	56.3
6	12	90.4	-	-	40	58.0
7	28	92.0	29	57.2	30	59.3
8	12	92.6	35	60.1	43	61.2
9	13	93.3	28	62.4	36	62.8
10	0	93.3	25	64.5	32	64.2
11	24	94.6	40	67.8	19	65.0
12	23	95.9	39	71.0	15	65.6
13	25	97.2	28	73.3	30	66.9
14	14	98.0	32	76.0	59	69.5
15	11	98.6	27	78.2	47	71.5
16	13	99.3	43	81.7	42	73.3
17	13	100.0	43	85.3	64	76.1
18		100.0	38	88.4	55	78.5
19		100.0	26	90.6	41	80.3
20		100.0	66	96.0	92	84.3
Oct 1		100.0	48	100.0	62	82.0
2		100.0			68	89.9
3		100.0			53	92.2
4		100.0			47	94.2
5					51	96.4
6					43	98.3
7		100.0			16	99.0
8		100.0			6	99.3
9		100.0			9	99.7
30		100.0			8	100.0
Total	1,841	100.0	1,208	100.0	2,309	100.0

Appendix Table 6. Numbers of coho salmon tagged by date, 1977.

Date	No.	No. Cum	% Cum
Aug 22	1	1	71
23	1	2	71
24	1	3	1
25	1	4	2
26	5	9	4
27	6	15	7
28	11	26	11
29	7	33	14
30	4	37	16
31	4	41	18
Sept 1	4	45	20
2	14	59	26
3	21	80	35
4	14	94	41
5	22	116	51
6	4	120	53
7	10	130	57
8	15	145	64
9	14	159	70
10	3	162	71
11	0	162	71
12	2	164	72
13	7	171	75
14	2	173	76
15	5	178	78
16	8	186	82
17	7	193	85
18	3	196	86
19	3	199	87
20	12	211	93
21	5	216	95
22	2	218	96
23	0	218	96
24	3	221	97
25	0	221	97
26	2	223	98
27	3	226	99
28	1	227	99
29	0	227	99
30	1	228	100
Total	228		

1/ Numbers of coho tagged by fishwheel run: Site 1 12
Site 2 9
Site 3 207

Appendix Table 7. Miscellaneous fish species taken by project fishwheels listed by wheel of capture, 1977 1/.

Fish Species	Wheel				
	Galena 1	Galena 2	Ruby	Total	% 3/
Cisco (Coregonus sp.)	273	195	-	468	33
Broad Whitefish (Coregonus nasus)	43	95	-	138	10
Humpback (Coregonus clupeaformis)	332	460	-	792	57
Unidentified 2/	-	-	639	639	
Total	648	750	639	2,037	
Sheefish (Stenodus leucichthys nelma)	9	2	1	12	
Burbot (Lota lota)	12	5	18	35	
Sucker (Catostomus catostomus)	0	1	68	69	
Char (Salvelinus alpinus)	44	59	40	143	

1/ For daily totals for wheel see data files.
2/ Ruby whitefish catches not broken down by species.
3/ For whitefish species percent of knowns only (1,398).

Appendix Table 8. Observed versus expected numbers of tag returns by bank and by sex of tagging for 1976 and 1977 1/ 2/

Site of Tagging	No. Tagged	No. Recoveries	Expected No. Recoveries	Chi Square	df
1976					
1	567	241	284		
2	650	365	324		
Total	1,217	609	609	11.38**	1
1977					
1	1,841	830	684		
2	1,208	421	448		
3	2,309	739	858		
Total	5,358	1,990	1,990	50.00	2
		Sex			
1976					
Male	680	341	341		
Female	537	267	267		
Total	1,217	608	608	1.51 NS	1
1977					
Male	3,240	1,228	1,202		
Female	1,986	711	737		
Total	5,226	1,939	1,939	1.48 NS	1

1/ Numbers recovered are assumed to be directly proportional to numbers tagged. For 1977 data 45 chums which were recovered were not identified as to sex at the time of tagging; 102 of the total chum tagged were not identified as to sex.

2/ Recoveries revised through September, 1978.

Appendix Table 9. Yukon chum salmon recovery data giving river mile and area, 1977[1/].

BY RIVER MILE

NUMBER	MILE	YUKON RIVER
2	0	Unknown
23	1- 529	Downst. Galena
58	530- 554	Galena - Lower
44	555- 579	Galena - Upper
114	580- 601	Ruby
5	602- 663	Birches
159	664- 684	Kallands
103	685- 692	Tozitna
98	693- 695	Tanana Vil.
94	696- 719	Dwnst.R.Rapids
212	720- 740	Rampart Rapids
170	741- 774	Rampart Vil.
36	775- 800	Hess Creek
45	801- 862	Stevens Vil.
0	863- 950	Beaver
18	951-1050	Ft. Yukon
2	1051-1110	Circle
5	1111-1200	Woodchopper
12	1201-1224	Eagle
12	1225-1835	Dawson City

NUMBER	MILE	TANANA RIVER
6	0	Unknown
14	695- 715	Lower Tanana
381	716- 775	Manley Hot Spr
16	776- 783	Kantishna Riv.
12	784- 850	Minto
221	851- 866	Nenana
1	867- 900	Wood River
6	901- 950	Fairbanks
2	951-1297	Upstream Fbks.

BY MAJOR SYSTEM

NUMBER	CODE	RECOVERY RIVER
1171	1	Main Yukon
2	2	Innoko
2	3	Koyukuk
659	4	Tanana
4	5	Chandalar
5	6	Porcupine
82	7	Toklat
4	8	Sheenjek
1	9	Fishing Branch
19	10	Delta

1/ Revised through September of 1978.

Appendix Table 10. Average numbers of miles traveled by location of recovery Yukon fall chums 1976 and 1977 1/.

Recovery Area	Mean Miles	Variance	N
Galena - Lower	9.00	7.41	(18)
Galena - Upper	12.96	97.59	(28)
Ruby	45.23	139.32	(134)
Birches	70.17	410.17	(6)
Kallands	110.51	721.59	(112)
Tozitna	105.80	757.75	(30)
Tanana Vil	139.46	187.91	(160)
Dwnsr. R. Rapids	145.20	170.51	(99)
Rampart Rapids	171.13	221.04	(150)
Rampart Vil	204.37	150.25	(116)
Hess Creek	231.39	33.80	(28)
Stevens Vil	290.71	249.09	(24)
Beaver	372.33	176.33	(3)
Ft. Yukon	447.08	40.24	(13)
Circle	530.50	1200.50	(2)
Eagle	662.20	21.29	(10)
Dawson City	742.89	461.11	(9)
Innoko	279.00	0.00	(1)
Koyokuk	202.33	12400.33	(3)
Lower Tanana	96.00	0.00	(1)
Manley Hot Spg	194.53	877.37	(240)
Kantishna Riv	197.25	744.20	(16)
Minto	210.00	484.00	(4)
Nenana	288.75	923.42	(193)
Wood River	354.75	110.25	(4)
Fairbanks	339.00	1108.50	(9)
Upstream Fbks	427.50	8064.50	(2)
Toklat	304.35	657.82	(108)
Delta	442.20	626.69	(20)
Chandalar	465.60	76.30	(5)
Porcupine	451.80	19.20	(5)
Sheenjek	542.75	56.25	(4)
Fishing Branch	1050.00	75.00	(3)
Combined	197.26	13828.41	(1560)

1/ Excluding negative and spawning ground recovery data.

Appendix Table 11. Average number of days at large by location of recovery Yukon fall streams, 1976 and 1977 1/.

Recovery Area	Mean Days	Variance	N
Galena - North	5.67	57.18	(18)
Galena- South	4.75	37.31	(28)
Ruby	6.36	44.34	(134)
Birches	8.67	9.87	(6)
Kallands	8.33	52.08	(112)
Tozitna	7.37	15.48	(30)
Tanana Vil	9.06	22.71	(160)
Dwnsr. R. Rapids	9.71	22.84	(99)
Rampart Rapids	10.16	22.46	(150)
Rampart Vil.	15.47	99.66	(116)
Hess Creek	11.57	8.70	(28)
Stevens Vil.	20.25	103.76	(24)
Beaver	18.33	32.33	(3)
Ft. Yukon	29.92	104.24	(13)
Circle	22.00	8.00	(2)
Eagle	26.10	38.54	(10)
Dawson City	36.11	30.11	(9)
Innoko	63.00	0.00	(1)
Koyukuk	18.33	72.33	(3)
Lower Tanana	4.00	0.00	(1)
Manley Hot Spr.	11.83	19.64	(240)
Kantishna Riv.	11.44	16.00	(16)
Minto	16.50	6.33	(4)
Nenana	18.80	39.31	(193)
Wood River	18.75	47.58	(4)
Fairbanks	19.78	29.94	(9)
Upstream Fbks	58.50	1200.50	(2)
Toklat	50.55	74.29	(108)
Delta	54.40	211.73	(20)
Chandalar	29.00	11.50	(5)
Porcupine	19.80	11.20	(5)
Sheenjek	31.50	57.67	(4)
Fishing Branch	45.00	7.00	(3)
Combined	15.49	187.59	(1,560)

1/ Excluding negative recovery data and spawning ground recoveries.

Appendix Table 12. Yukon River population estimations and exploitation rates of fall chum salmon.

	Total harvest[2]	Observed escapement	Calculated population	Undocumented escapement[3]	Rate of exploitation
			Upper Yukon[1]		
1976	72,000	78,000	149,000	0	0.51
1977	106,000	116,000	288,000	67,000	0.37
			Entire Yukon		
1974[4]	349,000	143,000	492,000		0.710
1975	337,000	634,000	971,000		0.347
1976	238,000	78,000	316,000	0	0.756
1977	333,000	116,000	513,000	71,000	0.649
1964[5]	136,000	-	131,000	-	-

1/ Above Galena tagging sites 1976, 1977 Galena and Ruby; revised 2-15-78.
2/ Total harvest includes both commercial and subsistence catches.
3/ Assumed to be difference in total harvest plus observed escapement and population estimation.
4/ No tagging program available for record level 1974 and 1975 runs on which to base population estimate. Calculated population given = sum of harvest and observed escapements.
5/ Hayes, 1974. For main Yukon above Rampart only.

Appendix Table 13. Yukon River population estimates and exploitation rates, 1977.

Year	Total harvest	Observed escapement	Calculated population	Undocumented escapement	Rate of exploitation
			Upper Yukon (including Tanana)		
1976	72,000	78,000	149,000	0	0.51
1977	106,000	116,000	288,000	67,000	0.37
			Tanana		
1977	61,000	56,000	115,000	-	0.53
			Entire Yukon		
1976	238,000	78,000	316,000	0	0.756
1977	333,000	116,000	513,000	71,000	0.65

Based on strong 1974 parent year escapements. A strong return of fall chums is anticipated in 1978.